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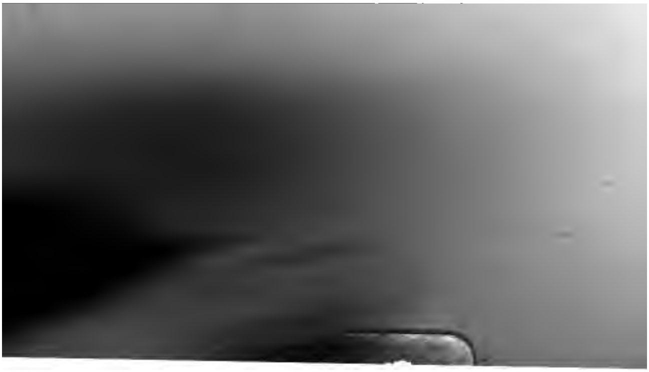

ON THE

MECHANICAL APPLIANCES

NECESSARY FOR

THE TREATMENT

OF

DEFORMITIES.

BY

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GUY'S; MIDDLESEX; KING'S COLLEGE; UNIVERSITY COLLEGE;
ROYAL FREE HOSPITAL, ETC.

Quam quisque nôrit artem, in hâc se exerceat.

PART II.

THE SPINE AND UPPER EXTREMITIES.

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PREFACE.

An author who knows that his works will probably be read by few save those who are best qualified to subject them to the test of a rigorous criticism, may be excused for manifesting no slight anxiety when he appears in the intellectual arena.

If he is making his first appearance, he does so with the trepidation of a novice who has everything to gain; if, on the contrary, he has won a recognised position, he stakes his reputation with every fresh venture. While the mere literary man cannot escape from these risks of his profession, those who only "dress themselves in print" to promulgate the results of their scientific labours, are placed in an even less enviable dilemma.

Good writing in their case will not excuse nor palliate bad reasoning, and in the majority of instances, the scientific writer is able to devote but slight leisure to anything save the daily practice of his calling.

In the present, I have followed out to the best of my ability the plan and execution of my former volume, and only hope that my readers may give as kind a reception to the descriptions of the Mechanical Treatment of the Spine and Upper Extremity as was accorded by them to my work on Club-foot and the Lower Limb.

HENRY HEATHER BIGG.

29, *Leicester Square, London,*
May, 1862.

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INTRODUCTION.

It is with much thankfulness that I at length put forth the concluding portion of the task which I imposed upon myself in 1857, and bring a classified description of what may fairly be termed the philosophical instruments of surgery before the public, as a complete and perfect entity.

The distinguished honour conferred upon me by H.R.H. the late Prince Consort, in accepting the first copy of my work, added to the kind, and, indeed, flattering reception which was accorded to it by many leading British and foreign journals, professional and lay, rendered me most anxious to finish my labours in such a manner as would show with what justice that pursuit, which is my chief pride and delight, may be acknowledged as a new profession, and rightly arrogate to itself the elevated social and intellectual status accorded to other scientific and liberal callings.

Thanks to the liberality of the medical profession, the fears of misapprehension under which I first ventured to address it, proved to be unfounded. Out of the thousands of medical men with whom it has been my privilege to come into professional contact since then, I can scarcely call to mind a single individual who had the bad taste, or illiberality, to insinuate any sinister motives as regards the publication of my *brochure;* on the contrary, I have received uniform kindness and courtesy, even from the majority of those gentlemen who might have inferred that I was an intruder upon their own special department of surgery. Indeed, many illustrious surgeons have not contented themselves with a mere tacit admission of the truth of my assertion, that "I live in an age in which it is no longer considered incompatible with the professional dignity of the surgeon that he should combine his talent and acquirements with those of the mechanist when engaged in the treatment of mechanical distortions, for I am well assured, that the interests both of science and humanity are better served by this combination of action in unity of purpose, than they would be if cared for by either singly," but have proceeded to prove their concurrence with my statement by practically adopting the sentiments enunciated.

Although I presume that many of my readers may have glanced at the first portion of this book, which was published early in 1858, under the title of "Deformities and their Mechanical Treatment. Part I. The Lower Limbs," I must ask them to acquit me of prolixity if I give a slight *résumé* of the leading points embodied in it.

In that *brochure*, I described the principal deformities of the lower limbs, with such instruments and appliances as were sufficiently excellent, or notorious, to warrant their introduction into the pages of a work which aimed at giving a concise view of orthopractic science, from its rise up to the date at which the book was published. A number of illustrative woodcuts simplified the descriptions, and these adjuncts I have used freely in the present volume. As Part I. was to a certain extent tentative and demonstrative, I judged it expedient to make the *theoretical* subordinate to the practical, only hazarding, therefore, a few of those speculations which every earnest man who works in a great gold-field of thought cannot well help indulging in, and never ventured upon these even, unless in illustration of some practical invention; but I foresaw that the Spine would require a bolder and more speculative kind of handling. My choice of the comparatively easy Lower Limb as the *experimentum crucis*, is then at once explicable, and, I hope, judicious. I propose, in the present work, to enter into an explanation, more or less elaborate, of such instruments as are highly applicable, or the reverse, to the treatment of deformities of the trunk and upper limbs, including a specification of the mechanical action of each apparatus; and I must crave the indulgence of my professional readers whenever, in stating the special advantages or elements of particular instruments, I am so unfortunate as to come into conflict with their preconceived ideas upon the subject. On such occasions, I trust that the arguments produced for, or against, any plan of treatment will not be considered as captious attacks, but be taken as they are intended to be, simple exponents of the views gained during a long and wide experience.

The science of Mechanical Orthopraxy* is so recently emancipated from its swaddling clothes, that it behoves every one who ventures an opinion to do so in all modesty and kindliness of spirit, for where all is comparatively obscure, none but a knave, or fool, would seek to guide dogmatically.

On this account, I have endeavoured to avoid an error only too common among the votaries of science—the allowing those principles only to be sound which they individually uphold; and have tried to give fair as well as perspicuous descriptions of various apparatuses, even where I have felt it to be my duty to express a preference for some special form.

It is lamentable to recal to mind how many men of the highest acquirements and genius have wilfully committed scientific suicide by obstinately fostering and defending, through life, some theoretical vagary suited only to the dawning epochs of human thought. Thus, many men of reputation, even in the present day, avow a belief in the restorative powers of unaided nature in the cure of deformities!! Fortunately for mankind, however, the votaries of the *vis medicatrix naturæ* are rapidly becoming as extinct as the Dodo is and the Apteryx will be. That these opinions must eventually lose credence altogether, is as certain as devoutly to be wished.

---

* I have adopted this word in preference to that introduced into the language of science by Andry, as expressing more clearly the purpose for which mechanical appliances are required in the treatment of deformities.

Andry suggested orthopædy from *ὀρθὸς*, *straight*, and *παιδίον*, *a child;* but orthopraxy, from *ὀρθὸς*, *straight*, and *πρασσείν*, *to do*, or *to make*, seems better calculated to convey the idea of treating deformities by mechanical agency.

On the other hand, there are many members of the profession who look upon the use of powerful mechanical apparatus as the sole great panaceum for all bodily distortions. As in analogous matters, so in this, *Medio tutissimus ibis* should be the motto adopted; and the system which employs mechanical agencies to such an extent as assists vital action, and yet abstains from exercising an inordinate amount of physical power, is the most scientific, most successful, and most likely to find favour at the hands of those philosophic thinkers who adorn the ranks of medical science. In furtherance of this object, it may be taken for granted that no appliance is favourably mentioned in this work unless its efficacy has been thoroughly tested by such an enlarged experience as rarely falls to the lot of one individual. All possible means have been resorted to for gaining an insight, not only into the construction and application of such mechanisms as are well known to the English profession, but also of those adopted and applied at the orthopædic institutions of Vienna, Berlin, Paris, Munich, Stutgard, Dresden, and most other large Continental cities where the practice of treating distortions has been established on anything like a scientific basis. From these personal researches, I am firmly convinced that, notwithstanding the attention bestowed by the powerful intellects of such men as Delpech, Stromeyer, Weber, Heine, Behrend, Langgaard, Martin, Bouvier, Guérin, &c. &c., on the mechanical treatment of deformities, in none of the Continental cities is the applied science involved in the construction of orthopædic mechanism better understood than in London. Sir B. Brodie, Messrs. Ferguson, Erichsen, Hilton, Paget, Holt, Brodhurst, Johnson, Partridge, Curling, Tatum, Solly, Little, and a large number of other English medical men, have as sound a comprehension of the mechanical *desideranda* for the treatment of deformities, and are as eager to fulfil them, as any of the foreign surgeons whose names have been quoted. It may, moreover, be added, that the powerful stimulus given by their deep interest in the subject has had a reflex action on the mind of the modern English mechanist, who, led by their example, loses no opportunity of perfecting the science of removing bodily distortions. Fifty years ago, when the whole system of treatment rested upon the manipulative skill displayed by the "instrument-maker," the remedying of deformities became distasteful to almost all who attempted it. Now that the advance of science has called forth new energies, formed new men, and created new paths, the construction and application of mechanical apparatuses are known to rest on laws only to be comprehended by those who make the highest branches of science their study. The man who devises and arranges instruments in the present day must have more than a slight acquaintance with the rudiments of

ANATOMY, to determine the position of the centres of motion in a joint, the direction and power of a tendon, the place of a bone, the presence of a nerve, the relative strengths and directions of muscular forces;

PHYSIOLOGY, to meet the requirements of respiration, circulation, fatty degeneration of muscular fibres, the power of tissues to resist compression, enlargement of blood-vessels when circumferential force is applied locally, and a variety of other physiological points too numerous to mention in detail;

SURGERY, to understand the effect produced by division of tendons, accidental luxation of bones, displacement of muscular and osseous substances, and a variety of dynamic changes incidental to operative treatment;

MECHANICS, to arrange the distribution of forces in such a manner that they shall be applied in the most immediate and economical manner; the directions assumed by various parts of the body after certain anatomical changes have occurred; the exercise of gravital force in its relation to muscular equilibrium, &c.;

PHYSICS, to take advantage of the laws that particularly pertain to animal forces, and their conditions when influenced by heat, electrical action, or any other occult stimulus.

With a strong belief in the necessity for his being well versed in these several sciences, can it possibly be denied that the educated modern mechanist justly ranks as a member of a new profession, in which theory and experience, invention and practice, speculation and achievement, are involved daily?

No sound logician ever attempts to start an argument without first stating his premises. It must, therefore, be held permissible for one who is about to describe the improvements and advantages deduced from any particular series of observations, to first demonstrate the ground upon which he bases his power of giving information. It might possibly be said that the mechanist could just as readily construct a perfect apparatus, if, confining himself to the inventive and adaptive part of the subject, he simply followed the instructions of the surgeon. This would be perfectly true if the body to be acted upon was made of wood or stone; but where so much delicacy of organization exists as in the human body, it is utterly impossible for success to attend the *application* of any orthopædic appliance, unless he who sees to its *construction* is capable of entering, co-ordinately with the surgeon, into the comprehension of the anatomical, physiological, and surgical difficulties to be severally encountered and conquered. Trusting that these preliminary remarks will be concurred in by those who read them, I enter upon the subject-matter of the work with a feeling that the position thus sought to be distinctly enunciated has been secured. It is perhaps remarkable that, notwithstanding that the treatment required for deformities of the upper extremities, and especially the spine, has excited the attention of a large number of able professional observers, hardly any of them have assigned such an amount of importance to the correct construction of mechanical appliances as the subject appears to merit. Neither have they made more than one or two special forms of instruments the objects of their eulogy. This has evidently arisen from an impression that the treatment depends essentially upon anatomical and physiological reasoning, and an idea that the mechanisms employed were but the *implementa medendi* of the loftier powers of Mother Nature. This reflection becomes the more striking, when it is found that those distortions of the upper extremities which afford a far larger scope for the exercise of mechanical orthopædic talent and ingenuity than any other portion of the human frame, are less considered, in their mechanical sense, by such authors, than club-foot and analogous distortions. Elaborate treatises have been written upon the extension of tendons after their surgical section, the various instrumental aids proper to be adopted for their restoration to normal length, and the mechanical care required to prevent retrogression; but in the same work, a few pages and some half-dozen illustrations of old and effete appliances are considered as sufficient to exhaust and dismiss the subject of spinal curvature. It is, nevertheless, well known that malformations of the feet and legs are very easily remedied by the aid of tenotomy; whilst those distortions which affect the spinal column not only fail to be ameliorated by this system of treatment, but offer the greatest possible amount of opposition and difficulty.

For some considerable time it has been customary to regard those deviations to which the spine is subject, as affording but little scope for benefit or cure. It can, however, be proved indisputably that far from these maladies proving irremediable, they admit of an invariable amount of improvement, when carefully handled, and in a large number of instances may be entirely removed.

But instead of expatiating, or rather generalizing, upon the causes that have led to failure in the treatment hitherto pursued, let me venture to insist upon the propriety of gaining a better knowledge of the principles upon which the action of mechanical appliances is based; otherwise that conservation of force which is supposed to be placed at the disposal of those who apply such devices, may be found fallacious and incapable of being serviceably employed when most needed. It is but too often discovered that whilst a variety of "racks and pinions" seem to give a pledge of ingenious and carefully elaborated mechanisms, the laws upon which such constructions are founded are imperfectly comprehended by those who affect to learnedly adopt and use them.

Before concluding these introductory remarks, let me call to mind the important function fulfilled by the spinal column, and its influence in maintaining the relative power and efficiency of the other parts of the body. Placed as the spine is, at the posterior region of the trunk, in which it holds a mesial position, any departure from its normal condition renders itself apparent throughout the whole body, and engenders, according to the degree of deviation, either mere awkwardness, or actual and complicated distortion. The spine likewise constitutes a column for the perpendicular support of the head, laterally of the ribs, and inferiorly and superiorly of those muscles which act upon the upper and lower extremities. It affords a fixed point for the attachment of many portions of the thoracic and abdominal viscera, and furnishes surfaces of resistance for the muscles which govern their action. The spine is to the rest of the osseous frame what the heart is to the vascular, or the brain to the neural system —viz., a general centre, in which the various parts find correlation and centres of dependence. To enable the spine to fulfil a condition so important, nature has rendered its structure extremely complicated. Composed of twenty-four separate bones (excluding the head and sacrum), it has, nevertheless, owing to its spinous and lateral processes, the strength of a solid column. Yielding in every direction, it yet possesses, through muscular tension, the power of enforced rigidity in its structure. Osseous in its structure, full provision is yet made, by the interposition of elastic cartilages, for every shock to which it may be subjected. No part of the body is more admirably adapted for the purposes which it is intended to fulfil, and none carries out in a more delicate manner the conditions assigned to it. At once the bony sheath of a large neural centre, and the distributor of innumerable sentient filaments, it submits to considerable force without injury, and offers one of the most beautiful solutions of a problem in which solidity and elasticity, rigidity and pliancy, rapidity of movement and paucity of space are combined, that could ever be imagined. The most perfect piece of mechanism designed by man falls far short of the simplest condition presented by the spine. Yet, notwithstanding this high amount of excellence, the vertebral column is subject to derangements of its natural laws, which for the time being pervert its uses, render its original intention obscure, and produce effects which, unless encountered and remedied, undermine the general health of the individual, and establish an amount of disease which may eventually lead to the destruction of life itself.

It is with these features of disturbance that we have to deal, in treating of the various appliances constructed for the purposes of antagonizing the ill effects resulting from a temporary suspension of any of those mechanical properties which are possessed by the spine in its healthy and normal condition. The scope of the work is also intended to embrace whatever form of distortion arises in either the shoulder, elbow, wrist, or fingers, and will thus serve to complete my description of a series of scientific mechanical appliances for the treatment of every variety of bodily deformity.

And now that I have stated, as succinctly as I am able, the scope and purpose of my undertaking, I cannot more fitly close the initiatory chapter than by expressing a hope, that whilst its contents may entitle me to the commendation of all those whose good opinion I desire to secure, they may, at the same time, by evidencing the purity of my motives, place me beyond the chances of acrimonious criticism.

ON DEFORMITIES,

ETC.

CHAPTER I.

DEFORMITIES OF THE PELVIS.

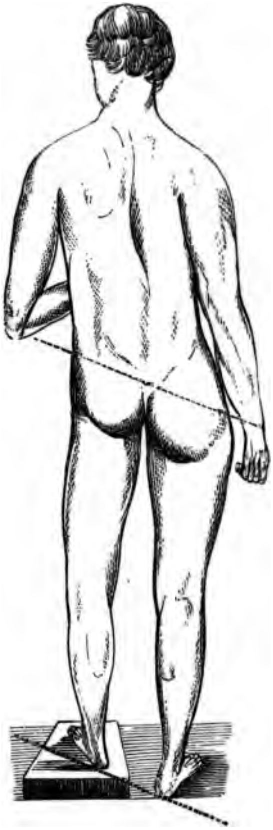
In the concluding pages of Part I., I described those distortions which are produced in the pelvis by morbus coxarius or hip-joint disease, together with the appliances which had been proved most efficient in carrying out the mechanical treatment required for the restoration of the thigh to its natural position.

In progressing gradually towards a perfect collection of apparatuses for the correction of deformities, it is imperative that I should define the classes of pelvic distortion which are most likely to be benefited by instrumental aid. Amongst the most important deviations from normal condition to which the pelvis is subject, is that termed horizontal obliquity; for, from the peculiar relation borne by the pelvis to the spine, so far as the maintenance of vertebral equilibrium is concerned, lateral disturbance of its horizontal position immediately engenders a deflection of the whole upper portion of the body, compelling it to assume a new condition of equilibrium, and laying the foundation for lateral curvature of the spine. Two separate causes lead to the pelvis becoming oblique in its transverse horizontal plane: one being structural shortening of the leg; the other, lumbar curvature of the vertebræ; and, as has already been stated, from the connexion that exists between the spine and the pelvis, it is utterly impossible that any disturbance of the one should occur without materially affecting the other. Thus, it behoves every one who is called upon to apply mechanical aid for restoring an oblique pelvis to its natural position, to ascertain with great care which of the two conditions just specified is the proximate cause of distortion. The plan I generally pursue, in order that I may determine this point, consists in placing the patient in a recumbent position on the floor, and then measuring the distance between the anterior spinous process of the ilium and the inner malleolus. This being done to each limb, it is at once seen whether one leg is absolutely shorter than the other, or merely appears so from the pelvis being uplifted by lumbar curvature.

Should the result be a discovery that one leg is structurally shorter than the other, the remedy for the pelvic distortion is of an extremely simple character, and consists in the substitution of a high boot for that ordinarily worn on the foot of the shortened limb. It is, therefore, merely necessary to first find the exact amount of difference between the length of the two limbs, and then interpose that thickness of substance between its sole and the ground, in the shape of a high-soled boot; one, moreover, not merely possessing a thickened heel, but having the whole surface raised; as, unless this precaution be taken, a contraction of the heel tendon is greatly encouraged.

Where no difference is found between the measurements of each limb whilst the patient is recumbent, and yet one foot is raised from the ground when the body is held erect, lumbar curvature of the spine will always be found to exist. In this case nothing can possibly be so injurious as to place any substance between the apparently shortened leg and the ground; for, instead of restoring the plane of the pelvis, and thus diminishing the original cause of deformity, it materially increases the deflection. The wiser plan and the one most constantly pursued, is, to attach a weight to the whole leg, and, by its elongating influence restore the plane of the pelvis by gradually approximating the heel to the ground. From the accompanying diagram it will be seen, that whenever a displacement of the pelvis exists in its horizontal plane, and the length of both legs is primarily equal, uplifting of one hip ensues. Although, therefore, at first sight it appears necessary to equalize the legs by artificially supplying the required amount of substance between the heel and the ground, yet, on reflection, the unscientific character of this arrangement becomes immediately apparent; for by interposing any extraneous material between the floor and the foot of the shortened limb, a greater perpendicular displacement of the pelvis must inevitably result, and its restoration to a normal position be rendered impossible.

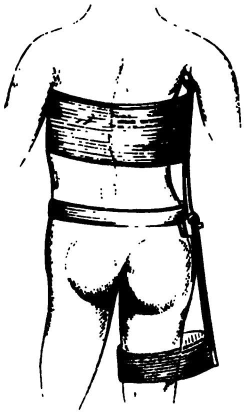
FIG. 1.



Whereas, by adding a reasonable weight to the leg, and only permitting the patient to walk on crutches, a gradual restoration of the pelvis to its proper place is so encouraged as to afford every chance of recovery. There are, however, means for effecting this object without necessitating the use of crutches—amongst them a very ingenious American invention has been arranged for the correction of this deformity.

It consists, as will be seen by the following diagram, of a metal stem articulated laterally at the hip, and furnished with a stop-joint so

FIG. 2.



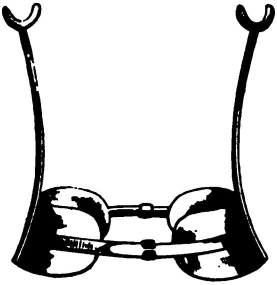
arranged that it prevents the thigh lever from becoming perpendicular. The upper extremity of this lever is secured by a laced webbing band to the chest, whilst the lower one is fastened to the thigh by a padded metal trough. The pelvis is also encircled by a padded strap, corresponding with the centre of articulation in the instrument.

When this instrument is applied it has a tendency to draw the thigh of the normal and sound leg in an outward direction; and this, since it renders walking impossible until the extended leg is replaced in its natural position, leads in its reaction to an uplifting of the opposite or depressed side of the pelvis, which is the object aimed at.

The next variety of pelvic distortions is characterized by a tilting backwards and upwards of its posterior or coccygeal region. This may either be induced by relaxation of those ligaments which retain the thigh bones firmly in their sockets, or may arise when, from disease or accident, the margins of the osseous cups in which the thigh-bones rest are broken or injured. The walking of a patient thus affected is distinguished by an uneven, rolling motion, which leaves an impression that the walker's body possesses telescopic articulations.

To counteract this, the following mechanical apparatus is usually adopted by me.

FIG. 3.

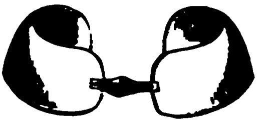


Two lateral sliding uprights receive the weight of the body, taking their bearing under the arms and transferring it to a deep pelvic trough, carefully moulded to the hips. Within this trough, and just above the head of the external trochanters of the thigh-bones, hard, semi-lunar pads are placed, and held in position by a band of steel accurately fitted to the pelvis, and grasping the whole of it firmly. Between each leg a padded strap passes, which secures the leathern shield in such a manner that upward displacement is rendered impossible. When this is adjusted, the patient's weight, instead of being received by a yielding pelvis, rests entirely upon the projecting trochanters, which being held firmly in their places by the pads and steel band, prevent any upward displacement: thus the pelvis becomes again restored to that condition of solidity which is imperatively demanded for the due fulfilment of its natural mechanical functions.

A third variety of pelvic distortion is created by horizontal displacement of the ilium; that is to say, by an advance of one hip in an anterior direction unaccompanied by shortening of the limb. This condition, although most frequently found in combination with spinal curvature, sometimes exists alone. When this is the case, the apparatus adopted is formed of two padded steel plates, hinged behind, and furnished with a rack and pinion-screw, so placed as to rotate one-half of the instrument in a backward direction. It thus makes that side of the pelvis which is in the best position a fixed point for its mechanical action, and then grasping the anterior surface of the opposite hip, drags it backwards, and at the same time rotates it upon the spine.

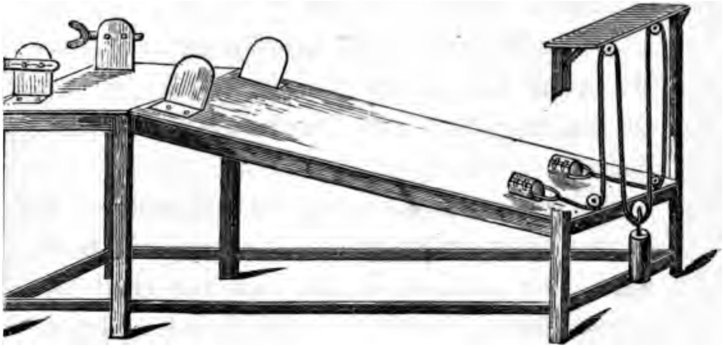
There is yet another form of pelvic derangement due to an inward yielding of the sides of the pelvis; but as all mechanical aid in such cases must prove unavailing, no apparatus for its restoration can be given.

FIG. 4.



Sometimes from relaxation of the ligamentous attachments connecting the hip, or rather thigh bones, with the pelvis, a rigidly contracted condition ensues, and tends to shorten the height of the patient, by tilting the lower part of the vertebræ backwards in such a manner as to create a deep lumbar hollow, which is frequently associated with lateral curvature. The mechanical appliance in these cases consists of a couch so arranged as to allow the arms and upper part of the body to rest on a horizontal surface, whilst the pelvis and lower extremities are permitted to remain at an inclination of about 25°. Beneath each arm a small crutch receives the weight of the head and shoulders, and at either side of the pelvis a padded plate, acted upon by a horizontal screw, fixes the hips firmly. On each ankle a padded band is fastened, to which leaden weights are fixed by cords running over pulleys at the end of the bed. These by their constant weight create traction against the hip centres, and gradually bring the legs to their proper length and position. After this object has been secured, the same form of appliance as that figured at page 24 is adopted, for the purpose of retaining the thigh bones in position.

FIG. 5.



Deformity of the pelvis in young and growing persons is invariably attended with considerable apprehension, more especially when the patient happens to belong to the female sex, on account of the importance socially assigned to the possession of an undistorted pelvis, and its relation to the functions of female life. This is so well known, that it becomes a matter of much anxiety to a patient's friends and medical adviser to prevent any temporary malposition from resulting in permanent deformity. Thus, standing on one leg (which is a habit common to almost all female children) should be most rigidly prohibited, as, in consequence of the horizontal displacement of the pelvis which it engenders interfering with the perpendicular position of the spine, two serious evils may be anticipated, namely, either a displacement horizontally of the pelvis, or the establishment of a curvature in the lower portion of the vertebræ.

The mathematical conditions assigned to the human figure, when placed in a perfectly perpendicular position, declare that the clavicles or neck bones, the pelvic or hip bones, and the *ossa calcis* or heel bones, shall hold parallel planes. Anything therefore calculated to disturb these horizontal lines at once displaces their common centre of gravity, and necessitates the adoption of a variety of distorted positions to enable the different portions of the body to retain their equilibrium. This change of position, when occurring in a comparatively small space of time, only affords an illustration of the elasticity and grace which characterize bodily motion; but when the disturbance of mechanical rest gives place to the existence of mechanical compensation, and that compensation is maintained for a lengthened period, then permanent redisposition of parts occurs, and the human frame recovers its equilibrium by a series of distorting displacements.

From the consideration of pelvic distortions we pass onwards to those deformities which affect the vertebral column; prior to doing which a brief exposition is given of the mechanical principles that govern the production of those curves from whence the deformities derive their distinctive appellation.

CHAPTER II.

THE RELATION EXISTING BETWEEN SPINAL CURVATURE AND ITS MECHANICAL TREATMENT.

ALTHOUGH the scientific amelioration of spinal curvature has afforded a subject occupying the time and attention of many able writers, little has been ascertained about even the primary principles of its mechanical treatment. Yet it must appear perfectly clear to the understanding of any man of ordinary sense, that to attempt the cure of spinal deformity without a proper degree of mechanical knowledge, is as false in principle as it would be for a geologist to lecture on cosmogony without knowing the sequence of strata.

I need hardly remark that it is not intended to commence an elaborate treatise on those abstruse mathematical and physiological principles which are confessedly essential to the judicious device and construction of orthopædic appliances. Still it is an incontrovertible fact that a by no means limited amount of knowledge of the forces called into play by the adoption of apparatuses for reducing deviations of the human vertebræ, is imperatively demanded on the part of those who make the treatment of such cases their special practice, and who, probably, can rely on no other guide than their own experience. Both deep and superficial writers have hitherto ascribed whatever paucity of information existed on this head to the fact that such cases were formerly entrusted to the care of men whose want of education, or public spirit, has disqualified them for rendering an extensive experience useful in founding a well-defined and scientific system of spinal mechanics. This accusation may be true in the limited sense in which it was evidently used; but it must, in fairness, be admitted that it is utterly impossible for a man of ordinary worldly shrewdness to have a certain class of cases constantly before him, without desiring, for his own credit if for nothing else, to furnish the world with a cue to his mode of meeting the various difficulties presented either to his mental talent or manipulative skill.

A very lucid and talented author has remarked, "that without analytical reasoning experience is a blind guide." This observation is undoubtedly correct; but it is hardly to be imagined that, in this age and country, any professional man of moderate judgment would gather his experience without imbibing such an amount of analytical power as would render his personal observations of a scientific and permanent value to mankind at large.

It has hitherto been but too easy to characterize by uncomplimentary epithets, such as "charlatan" or "empiric," those whose path in life has led to the investigation of truths not previously generally elucidated; but a dispassionate view of the matter at once compels any just observer to admit, that whenever the bent of a man's nature or character becomes directed to an untrodden field of research, he invariably establishes for himself a new path, and overcomes such obstacles as mainly retard his advancement.

These observations are intended to apply to the ignorance charged against those English mechanists who made the study of deformities their occupation prior to the rise of the modern school of Orthopraxy,* which, more than anything else, has given scope to the development of high class constructive and mechanical intellects.

Every credit is due to men of exalted minds, like Delpech, Scarpa, Stromeyer, and Diefenbach, for their efforts to place the treatment of deformities on a perfect basis; but it is narrow-minded and invidious to declare that none but these apostles of orthopraxy understood the curative treatment of deformities. Undoubtedly the fact that cases of the kind were generally placed in the hands of mechanicians annoyed those who desired to see a more surgical method of treatment established; but despite the improvements effected by tenotomy in distortions of the lower extremities, the leading members of the profession agreed, and still agree in believing that to mechanical means, and to mechanical means alone, must be entrusted the rectification of spinal curves. It may therefore, with strict justice, be advanced that, notwithstanding the progress made in every branch of operative science, spinal curvature can alone be successfully encountered by mechanical agencies. Whatever therapeutic remedies have been attempted, whether medical, change of air, shampooing, section of muscles, electricity, peculiarity of diet, or any other supposed panaceum, the result has ever proved valueless unless associated with the restorative principles of rest, semi-recumbency, antagonizing force applied to curves, thoracic support, extension of vertebral arcs of deflection, and other well known plans of mechanical action. On these grounds it must be admitted that spinal curvature requires physical elements for its active correction, and that unless they are zealously employed, all other means will be of no avail.

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* Ορθος, straight; Πρασσειν, to do, or make.

Long before the introduction of that grand orthopædic discovery of modern time, tenotomy, or division of tendons by cutting, had rendered deformities of the extremities amenable to surgical treatment, it had been decided by all who had studied the subject of vertebral maladies, that distortions affecting the spinal column offered the greatest possible difficulty, both to the surgeon who examined them and the mechanist who applied devices for their cure. Tenotomy in vertebral curvature has been fairly tested, and it is now admitted that although section of tendons almost entirely overcomes the opposition encountered by the mechanician, when seeking to adapt appliances of sufficient power to restore equilibrium of force and action to lapsed and distorted parts of the upper and lower extremities, it only serves to embarrass his calculations, when adopted for lessening the contraction of muscles within arcs of spinal curvature. In consequence of the reliance, therefore, that the patient must place on correct mechanical aid, the wisdom of the present scientific age has determined that the real palliative for spinal deformities can alone be found in a combination of surgical skill and orthopractic talent, and they not often united in the same person.

When an able surgeon is assisted by a clever mechanist, the successful treatment of vertebral distortions becomes a matter of all but certainty. Thus it is almost an established rule, that upon the discovery of a vertebral deflection, the first important point to be considered is, "what form of spinal instrument is likely to reduce it with the least amount of inconvenience to the wearer?" The importance of this point is so considerable, that it behoves the professional adviser to insist strongly on the dismissal of every scruple as to interference with the arrangements of dress—disinclination for wearing an instrument—unwillingness to encounter the care and supervision necessary upon the adoption of a mechanical apparatus—or any other ordinary phrase of objection, with which parents, patients, and friends are but too often inclined to reject advice comprehending any opposition to the ideas and prejudices established by fashion or costume. For the satisfaction of those who found their objection to the use of apparatuses on any of the grounds just mentioned, it may, however, be stated with perfect truth, that when a carefully constructed spinal support is used, not only can the customary dress be worn, but the amount of professional attention required becomes a matter of absolute satisfaction through the progress insured: and after a very few hours the patient loses all sense of having anything of the kind on her body, when a feeling of increased health, vigour, strength, and symmetry fully compensates for the fear and nervous timidity so frequently entertained upon the adoption of a spinal instrument being first talked about.

From these remarks it will be gleaned that for so complex a part of the organization as the spine, the utmost pains must be taken by the mechanist to whom the construction and adaptation of the required apparatus is entrusted, in order that each artificial mechanical lever shall precisely coincide with the position assigned to it by those mathematical and surgical laws which fix the direction in which its force should be exercised, and the axis of its motions.

Every spinal distortion having, as is well known, certain arcs of deflection, or curvature, with their respective centres and extremities, it becomes vitally important for us to comprehend clearly the structural changes engendered by the expansion of vertebral curves, and the compression of their component surfaces. At the risk of appearing invidious, I am bound to state that more than one orthopædic surgeon, even of the present day, entirely overlooks this great primary principle, upon which alone deformities of the trunk can be treated in a philosophical spirit.

Lest these observations might be unjustly referred to an improper motive, it is only necessary to refer the reader to those subsequent pages where the injurious compression exercised upon the ribs by some especial, and hitherto favoured, form of apparatus is described; the mal-direction of force presented by others is stated; and the frequent neglect to take into consideration the compensation of curves, is freely commented upon.

To return, however, to the more congenial and gracious part of the subject; it must be admitted that even a superficial knowledge on these points demands much study—anatomical, physiological, statical, dynamical, and mechanical. Each separate element must be well weighed before the mechanist can combine and arrange those instrumental powers which are intended to act against living opponent forces.

To demonstrate by logical reasoning the relation existing between spinal curvature and mechanical treatment, let us be permitted to assume that spinal curvature originates primarily, apart from any predisposing physiological cause, in an unequal distribution of gravital force upon the intervertebral cartilaginous substances, leading to an absorption of material on the depressed side, and the production of a wedge-like seam between the articulating surfaces of the various vertebræ.

That, secondly, a retraction of the small but powerful fibres of intervertebral ligaments and muscles takes place on the side where depression of the cartilages has occurred.

That, thirdly, a false system of equilibrium is compulsorily established, by the creation of a series of two or more spinal curves antagonizing each other in force and direction, and solely established for the maintenance of the head in its perpendicular relation to the feet.

And, fourthly, that the muscles situated within the concavity of the resulting curves become structurally shortened by disease and diminished areas of action.

Now what should rightly be the system selected for redressing this disturbance of natural functions and laws, which all who understand the nature of spinal curvature will admit the existence of, in cases of ordinary severity? It can hardly be therapeutic; for how can the muscles regain their tone and elasticity, the osseous curves unfold themselves, the ligaments expand, and the cartilages recover their lost substance by mere medicinal remedies? It must surely then be mechanical, for by this means alone can the curves be elongated by pressure upon their arcs and expansion of their extremities; the muscles brought into use and power by gymnastic exercises; the ligaments expanded by thoracic support, and the intervertebral cartilages enabled to gather fresh substance, by a removal of that superincumbent weight which prevented physiological deposition of new material.

It is to exhibit in a tangible way how this result can be assured, as well as to declare the dependence that all treatment of the vertebræ has upon mechanical aid, that these pages are written. Of the truth contained within them, an impartial professional public must be the best judges.

It is now merely necessary to reconcile the plan of treatment required with the means taken for its fulfilment, in order to show that at the present time hardly any deformity exists which time and talent, care and caution, intelligence and ingenuity, surgery and science, mechanics and machinery, cannot eventually reduce to the simplest conditions of arrangement, and finally restore to its true, normal, and primary condition.

As these pages may occasionally fall into the hands of a non-professional reader, to aid his comprehension of those terms which are employed in the description of spinal curvature, it may probably be advisable to offer a brief description of the vertebræ composing what is called the spine.

The spinal column* consists of twenty-four bones or vertebræ, divided into three regions, and respectively named the cervical or neck portion (seven bones), the dorsal or back (twelve bones), and the lumbar or loin region (five bones).

The whole of these are conjoined by strong ligaments, acting in a powerful manner anteriorly and posteriorly, but less so laterally, and fixed to large bony points of attachment called processes, which spring from the sides (transverse processes) and back (spinous processes) of each individual bone, and serve to lock, or rather articulate, the entire spine together. Every separate bone rests upon a bed of cartilage, which peculiar substance affords an elastic base, prevents dangerous proximity when under concussion, and gives that pliancy to the whole column which at once constitutes its beauty and its use. Fixed to the transverse and spinous processes, and attached to the adjacent osseous surfaces furnished by the ribs, pelvis (or hips), and arms, are the various muscles of the spine, of which there are six distinct layers, affording mechanical motion in every direction, and enabling the body to maintain that perfect condition of equilibrium which is requisite for its functions as the central column of the skeleton. To the sides of the vertebræ, the ribs are joined by articulative processes, and they afford by their arched shape a strong support both to the muscles of the spine and the vertebral bodies themselves.

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* Excluding the pelvic bones, and the head, which is, according to the Transcendentalists, formed of expanded vertebræ.

The spine itself when dissected and viewed from the side exhibits three natural curves, of an extent corresponding with the number, form, and position of those bones which compose each arc. One arches anteriorly and forms the neck; a second bends posteriorly and constitutes the back; and the third exhibits itself anteriorly, originating the loins.

The object of the spine and ribs, in addition to offering points of fixture for their respective muscles, is to support and balance the head, for which purpose the spine attains solidity by being joined to the hips or pelvis, which latter organization retains its condition as a *point d'appui*, or fixed point, in almost every condition of the body in its quiescent state. When in motion, the centre of gravity, found, by the researches of an able German physiologist, Weber, to be placed in the point of junction between the spine and pelvis, rarely rises more than a slight space above the attachment so formed, hence the equilibrium between the head and body is left almost undisturbed. The vertebræ also give protection and passage to a prolongation of the brain, called the spinal marrow (*medulla spinalis*), which, in its turn, furnishes those nerves by which the body derives its sensation and power. Thus, anything, deformity or otherwise, tending to produce pressure upon these substances impairs nutrition, volition, and interferes very greatly with the proper exercise of all the functions of the human body.

So important a region demands especial care; hence the Grand Geometrician of the Universe has placed it at the posterior surface of the thorax or chest, giving it the ribs for its support and the arms for its defence and protection. Yet, notwithstanding the care bestowed by Nature in placing the spine at that part of the body which is less exposed to injury from external attack than any other, it is subject to grave disturbance of its primary mechanical conditions; and to this departure from ordinary character the name of spinal curvature has been assigned.

To constitute spinal curvature those conditions established for the maintenance of symmetrical action must be suspended as far as the spine and its relative parts are concerned. Thus, any debility of bodily constitution may lead, by impairment of tissue, to loss of supporting power in the muscles of the back, which, if maintained for a period sufficiently long to induce re-adjustment of equilibrium, invariably leads to structural shortening of the ligaments between the bodies of the vertebræ, and eventually results in compression of the cartilaginous substances between the bones themselves. Thus, either by muscular weakness or cartilaginous yielding, a deviation of the spine from its vertical position may occur. As, however, one of the objects of the spine is to balance the head, which would fall aside upon disturbance of equilibrium, Nature, in her beneficent provisions for the maintenance of equipoise, establishes a series of curves by which a vertical and, consequently, gravital line is secured irrespective of lateral deflection. On this important condition—namely, the production of a geometric number of curves—more than on any other, depends the facility we possess for redressing spinal curvature. For whilst Nature, acting in one direction, establishes curves, Art, by comprehending their construction and adopting an antagonistic course of action, unfolds them.

The mathematical theory upon which the construction and reduction of curves are based will be found detailed in full in a subsequent part of the book. For the present, it is only necessary to bear in mind that no condition of curvature exists which cannot be measured and calculated by mechanical processes; and that, where the presence of youth, suppleness of frame, and moderate strength of constitution favour the result, rectification, either entirely or partially, infallibly ensues upon the adoption of well-devised and carefully-adapted scientific spinal appliances.

Before quitting the subject of the mechanical functions performed by the vertebræ, it may be related as a proof of the imperfect judgment occasionally passed upon such matters, that an ingenious modern writer has sought to prove, with greater credit for novelty than for his scientific attainments, that the spine and ribs are so evenly held in equilibrium by their own osseous structures, that the vertebral muscles only maintain a condition of "vigilant repose;" but are ever ready to assert their influence when called upon to act by any change of posture which the body may assume. This *might* be true while the human body rests on a chair, or leans against a wall, but cannot be so under ordinary conditions; for so constantly are the re-arrangements of local equilibrium called into requisition by the vital functions of the body, such as inspiration, abdominal motion, action of the heart, movement of the head, and various other comparatively trifling degrees of motion, that the muscles of the spine are always in a state of active tension, instead of passive vigilance. Take, for instance, the act of drawing in the breath, and think what ensues. Firstly, the air upon entering the lungs extends their cells and changes the gravital centre of the entire thorax in its relation to the vertebræ. Secondly, as the lungs derive their support from the ribs, and these are primarily held by the spine, it follows that any mechanical pressure made within the chest must be transferred to the bodies of the vertebræ. Thirdly, to prevent these from yielding in a direction concurrent with that of the additional force, those muscles (erectores spinæ) whose function it is to retain the spine in an erect position, are called into active operation. Thus every idea of "vigilant repose" is disposed of, while from the simple circumstance that inspiration is immediately followed by respiration, which in its turn induces a certain amount of muscular reaction in the region of the spinal column, it necessarily follows that the spinal muscles are kept in a state of constant activity.*

Mr. Bishop, whose researches have been of a far more comprehensive character than those of most writers on the subject, asserts, with self-evident truth, that the erect position of the body is that in which there is the *least* expenditure of muscular action; but he does not go to the length of saying that the muscles assert no action, but are only in "vigilant repose." The error on the part of the author who has coined this singular expression, would hardly have attracted attention had it not been coupled with an expressed intention of founding upon it an argument calculated to intellectually annihilate those who, like myself, consider unequallized muscular activity as one of the primary and most important causes of spinal curvature. It could, if necessary, be also easily proved by the well-known description of the ordinary and natural spinal curves given by Weber, that the muscles on the concavities must always be in a state of tension in order to support the weight of the head; hence the theory of "vigilant repose" becomes, in a mechanical sense, a specialistic misnomer.

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* If the writer referred to had, in seeking to explain his theory, used the term static energy, he would have been logical and correct.

It is not, however, with the hair-splitting theories of modern orthopædic writers, but rather with the practical deductions gained from their experience, that I have to deal in the present work; whilst seeking to show the correlation that exists between the treatment of spinal curvature, and the possession of mechanical appliances calculated to effect the amelioration of vertebral deformities in a scientific manner.

It must be clearly understood, that although the remedial treatment of spinal curvature largely depends upon mechanical assistance, yet, prior to such being adopted, it is necessary that the surgical conditions of the case should be thoroughly comprehended; for which purpose I take it for granted the friends of the patient will first consult their medical man, and ascertain from him that mechanical treatment is advisable. After this is decided, suitable appliances must be obtained. For determining the character, nature, and position of spinal curvature, the surgeon's aid is indispensable; and this being done, the mechanician's art is as highly important. When combined in treatment, all the success that modern science can achieve is placed at the disposal of the patients, who find their simplest safeguard to be a reliance on the united aid of both surgeon and mechanist.

CHAPTER III.

ON THE PRODUCTION OF VERTEBRAL CURVES.

In a work which professes to treat of those mechanical appliances which are devised for the amelioration of spinal curvature, it will necessarily be expected that some attempt shall be made to explain the mode of formation and nature of those curves by which vertebral deformities are not only anatomically distinguished, but derive their name and character. Whilst it would be both absurd and pedantic to enter into such algebraic formulæ as express the mathematical proportions borne by the magnitude of the various arcs producible by curving a given straight line, yet none of my readers can do otherwise than desire an explanation of the manner in which the spine assumes a distorted position—with the deflections that ensue—and the relation held to each other by the curves so constituted. It should first, however, be taken for granted, that owing to the impossibility of subjecting the spine to the strict scientific analysis which might be applied to the movements of a homogeneous and elastic column, all observations must necessarily be of an approximative character. Thus, for example, if I were to say, that in order to maintain the spine in an erect position, muscular power must be equally exercised upon each transverse vertebral process; it would also be necessary to state that a diminished amount of resilience, in one or more of the inter-vertebral cartilages, must completely destroy the correctness of any arithmetical calculation founded upon the known system of antagonistic muscular forces.

I shall, therefore, proceed to consider the spine, and its adjacent parts, after the manner in which they present themselves to the most ordinary observer when assuming any change of direction bearing a relation to the production of spinal curvature.

The spine in its quiescent state, that is to say, when the body is erect and motionless, presents, at its posterior region, a perfectly vertical line, having the head at its superior extremity, and finding a horizontal base in the transverse axis of the pelvis. When the head and pelvis are in this position, each single bone forming the spine has its perpendicular axis in a line corresponding with one drawn from the base of the skull to the sacro-coccygeal articulation, which said line divides the pelvis into two equal parts. Whilst in this condition the weight of the trunk is evenly distributed, and the gravital forces are in perfect equilibrium, as may be proved by showing that the angle formed by the spine and ilium on the right side of the body corresponds precisely with the angle existing on the left side.* Thus the head, trunk, and upper extremities are found to be in equipoise, and so long as the mechanical powers that sustain this state of things remain undisturbed, the whole external form presents an appearance of symmetrical balance. The slightest movement, however, serves to derange this system of equilibrium; but in the healthy and vigorous frame it leads to the formation of other arrangements equally well calculated to preserve the component regions of the human body in a state of balance, although occasionally doing so at the expense of a true symmetric disposition of relative parts.

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* *Vide* Fig. 6, No. 1.

When the spine, which forms the general centre in all movements of the trunk, can re-assume with facility the perpendicular position first described, after having yielded to whatever accidental disturbance may, for the time, have led to the adoption of a deflected position, it is said to be free from curvature, and its possessor to have a straight spine. It is, therefore, palpable that deformity of the spine only exists when it is incapable of resuming its vertical position. But as the osseous portions of the spine rest upon beds of elastic cartilage, which may become organically deteriorated in portions of their structure, a very fertile cause of disturbance is at once established; add to this, the circumstance that even the muscles are not always in the same state of physiological activity, and it becomes evident that two excitory elements, of no slight character, constantly threaten the mechanical equipoise of the spinal column. Whatever may be the active principle that leads to interference with healthy and natural physical balance, the result is apparent, compelling one or more bodies of the vertebræ to depart from the true vertical line hitherto held by them, and as the head thus temporarily loses, to a certain degree, the base that sustained it, an addition of its weight is given to the yielding side. Lateral vertebral obliquity ensues, which is met, on the part of the head and upper portion of the spine, by a strong muscular effort to restore themselves to their original position. If the cause of the deflection were only due to ordinary muscular action, the effort thus made would bring the spine back to its primary straightness; but as it is assumed that the diminished intervertebral substance leads to a rigid approximation of the yielding bodies of the vertebræ, the head can only be restored to a point vertical with the plane of the pelvis, by flexing another part of the spine, either above or below the original vertebral arc. This forms at once the simplest instance of the production of ordinary spinal curvature, but to render it intelligible the following diagrams are necessary.

FIG. 6.

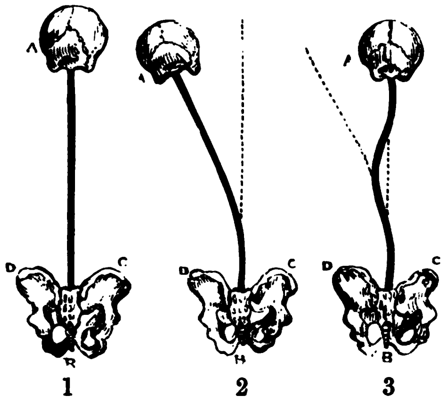


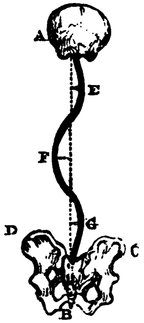
Fig. 1 represents the natural position held by the spine, head, and pelvis, A B being the vertical, and C D the horizontal planes.

Fig. 2 assumes the condition engendered by an unequal approximation of the bodies of the lumbar vertebræ on their left side.

Fig. 3 exhibits the effort at compensation made by the upper part of the spine, and the resulting formation of a secondary curve.

In these drawings it will be perceived that when the head returns to its primary position, it does not do so by an entire obliteration of the curve that followed its displacement, but by transferring a small portion of the arc of curvature *beyond* the line of gravity, and setting up another of a proportionate magnitude opposite to it, by which the equilibrium is at once restored, although by the mischievous production of two curves instead of one. Should, however, those muscles situated between the dorsal concavity and the pelvis act with increased vigour, whilst the first deflection (G, fig. 7) is in the course of formation, it is then perfectly possible that the effort made by the head to bring itself back into its normal position, would so favour the exercise of this muscular activity as to induce a disturbance of balance by bringing the head again out of equipoise, but on the right instead of on the left side. This, upon the head becoming restored, would lead to the formation of a tertiary or third curve, to ensure equilibrium between head, spine, and pelvis. The following diagram not only explains the position retained by the spine after the production of a third arc of curvature, but points out the manner in which equipoise becomes established through the medium of the created curves. A careful study of this effect is necessary, as upon it I have founded a theory for redressing spinal curvature, by acting against the primary arc of deflection; to understand which a slight recapitulation of the manner in which the three curves are formed is expedient. First, the spine yields towards the left side, forming the curve G. To re-establish the equilibrium which has been disturbed by this process, the head and upper part of the spine are moved to the right side, thus creating the curve F. In consequence, however, of the muscular traction exercised between the right side of the pelvis and the concave dorsal region, the head is carried too far in this direction, which necessitates the formation of a third curve, E, to bring it into its original position.*

FIG. 7.



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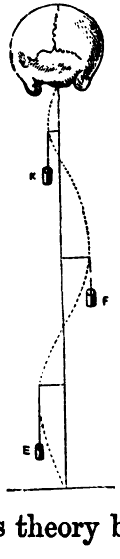
* Although in this illustration the original curve is assumed to be in the lumbar region, the same consecutive reasoning may be applied whenever the primary deflection exists in any other part of the spine.

It will moreover be seen that a line at F, drawn at right angles from the apex of the great arc of dorsal curvature on the left side to a true vertical line between head and pelvis, is exactly equal in length to the sum of two lines drawn from E G, the apices of the opposite curves, at right angles to the same vertical straight line, thus showing that the same gravital force is exercised upon either side of the vertical line drawn from the base of the skull to the centre of the pelvis.

FIG. 8.



To illustrate this theory by a simple mechanical experiment, let us suppose an upright semi-elastic rod to have three transverse arms attached to the parts corresponding with the centres of spinal curvature. If a weight of 10lbs. were suspended at E, the whole rod would yield, and ultimately fall to the left side; but if 12lbs. were placed at F, then the rod would yield to the right side, and the only means by which it could be kept in equilibrium would be to place 2lbs. at K.

It may here be stated that the reason why the spine exhibits such a marked aptitude for establishing a series of curves, depends greatly upon the elasticity of its formation, for, consisting as it does of several separate bodies, each having a distinct centre of motion, and these being influenced by the elastic substance (intervertebral cartilage) placed between them, it follows that the slightest horizontal deviation in any one component part leads to a disturbance of stability in the whole column, and produces effects already detailed in the preceding pages.

Upon a clear understanding of the manner in which vertebral arcs are formed, more than on any other cause, depends the correctness of the treatment by which their reduction can be undertaken. Viewing the pelvis and spine in the light of a mechanical problem, it becomes necessary to illustrate in an easily intelligible manner the mechanical change that occurs in the production of abnormal deviations.

It is well known that a considerable amount of weight can be borne on the apex of a perpendicular column without inducing lateral deviation, but should any cause arise tending to displace the base upon which the column rests, or make it offer a diminished resistance in any part of its structure, disturbance of equilibrium is immediately engendered, and the weight no longer rests in equipoise over the base of support, but inclines to that direction from whence the disturbing cause proceeds.

If the weight were left to itself, it would speedily fall; but taking it for granted that the column is composed of elastic material, and possesses sufficient power of adaptation to yield in any direction particularly favourable to the restoration of the displaced weight, then a rearrangement of the force hitherto employed to sustain the column erect would occur, and a series of curves be the result. For owing to the mechanical law of gravity, it would be impossible for the column to re-arrange its elemental conditions, except by resorting to compensating arcs of deflection; to prove which, let it be supposed that a weight of ten pounds rests upon the extremity of an elastic column twenty inches high, and that, in consequence of some structural defect at a distance of five inches from its base, the weight causes it to yield in a curved form to the right side. It follows, that the only means by which the displaced weight can be restored to its first position, without unfolding the primary curve, is by producing a deflection in the column to the left side at five inches from the top, and bringing in this form the whole structure into such a position as to make a vertical line from the centre of the column (at ten inches from either end) fall within the base. This establishes equilibrium, and offers an example of that which takes place in the formation of spinal curvature.

It will thus be seen from these examples, that the two great principles into which all mechanical powers are divided—viz., pressure and motion, or statics and dynamics, are both brought to bear in the formation of spinal curvature. For whilst the ligaments, muscles, cartilages, and bones offer statical resistance to the creation of distortion, when the whole are in their healthy and highly organized condition, keeping them in equilibrium, any physiological disturbance of their proximate conditions engenders dynamic changes, which result in the formation of two or more arcs of distortion.

One highly important inference may therefore be drawn from this brief exposition of the creation of spinal curves, which is *the impossibility of one arc of curvature ever existing without a secondary curve of compensation being established.* Too much importance can scarcely be attached to this axiom, although it is constantly set at nought in those absurd plans of mechanical treatment which are so frequently promulgated.

These remarks are only intended to afford a very elementary description of the formation of spinal curves; but in the chapter devoted to double lateral curvature, the subject is more minutely entered into in its practical bearing, as I found it impossible to render the action of the required apparatuses intelligible, without, at the same time, giving a description of the curves which they were intended to act against and overcome. To avoid repetition I have, therefore, divided the description of the formation of curves between these chapters.

CHAPTER IV.

LUMBAR CURVATURE.

WHETHER spinal curvature exhibits itself primarily in the dorsal or lumbar regions is a much controverted point. Mr. Skey believes that lumbar curvature is the earliest; and his reasons are, that Nature has given the loins greater freedom of motion by placing that part of the body midway between the head and feet, so that the divergent lines of obliquity formed by those portions of the body meet in the lumbar spine. From this he infers that, in the majority of cases, the primary seat of curvature is the loins.* The intelligence, learning, and experience of Mr. Skey entitle this opinion to much respect; nevertheless, it is the duty of every scientific mechanician to ascertain for himself how far it is consonant with his own observations. Dr. Little thinks that the part of the column principally affected is the dorsal region; and in the greatest number of these cases the vertebræ incline from the perpendicular position towards the right side.* He adopts the authority of Dr. Bühring, who asserts this peculiarity to be due to a thoracic curve which always exists on that side, owing to the spinal column being unequally loaded by the heart and great blood-vessels on the one side and the liver on the other. In further support of this theory, Mr. Hare urges that the earliest sign of deformity is a slight curvature of the vertebræ in the inter-scapular region.† He also adds, that Beclard says that this occurs because the right arm is most used. Mr. Lonsdale, who hardly admitted the possibility of a lumbar curve in the treatment proposed by him for the cure of lateral distortion, declared that, *when* a second deflection exists, it occupies the lumbar region, thus proving his belief in the primary existence of dorsal deflection. The reader, from these expressions of opinion, might be led to infer that spinal curvature rarely occurs in the lumbar region disassociated from dorsal deflection. There are, however, conditions under which this variety of distortion presents itself; and such being the fact, a description of the appliances intended to meet such exceptional conditions will form part of the present work.

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* *Vide* "Practical Essay on Lateral Curvature of the Spine," pp. 4—6.

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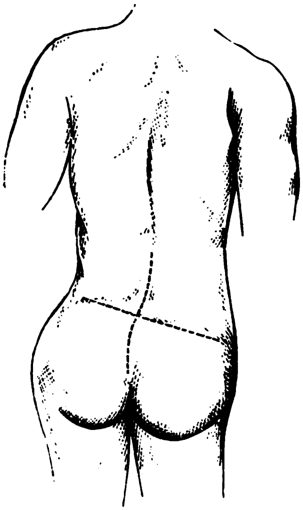
* Little, "On Deformities," p. 365.

† Hare, "On Spinal Disease," p. 64.

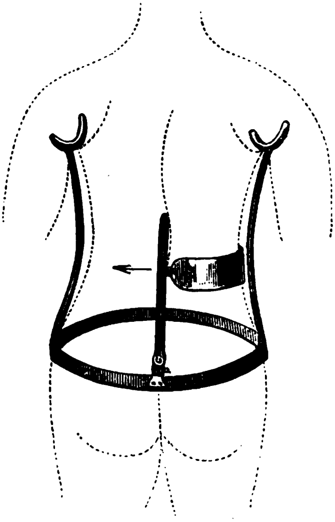
Lumbar curvature may exist in three distinct directions, viz., lateral, posterior, and anterior. The salient features of lateral lumbar curvature are an unequal prominence of the bony and muscular structures forming the loins, with an approximation between the hip and lower margin of the ribs on the side opposite to that of the lumbar protuberance; it is, moreover, almost invariably accompanied by obliquity of the pelvis, leading to shortening of the leg as a compensation for disturbance of vertebral equilibrium. Owing to the amount of pelvic displacement generally engendered by this condition, the shoulders of the patient do not so much deviate from their naturally horizontal position as would at first be supposed. The following diagram explains the conditions presented by this deformity. It will be seen, by this drawing, that the left ilium or hip is upraised, that leg being shortened and the right side of the lumbar vertebræ enlarged. The same condition of deformity may exist on the opposite side, when the relative position of

FIG. 9.



the leg and lumbar arc become reversed. To remedy this deformity it is necessary to restore the level of the pelvis, whilst simultaneously overcoming whatever arc of vertebral curvature may be presented. The simplest apparatus for so doing may be thus described:—Two lateral stems support the arms, whilst the hips are encircled by a narrow padded belt formed of light metal. On the highest point of the vertebral deformity a padded plate rests, which is fixed to a posterior lever having a ratchet motion at the sacral part of the pelvic band.

FIG. 10.

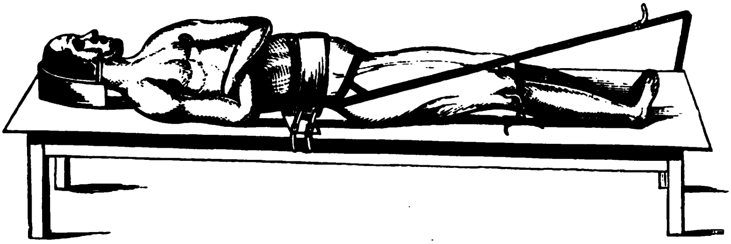


To bring this into action the ratchet-screw must be turned from right to left, which produces a movement of the lumbar plate or pad in the same direction. This creates a reactive force against the left hip and axilla, tending to diminish the lumbar curve and depress the uplifted pelvis.

This form of apparatus possesses the advantage of being portable and easily concealed by the dress, and has consequently been adopted by almost all the leading surgeons of England.

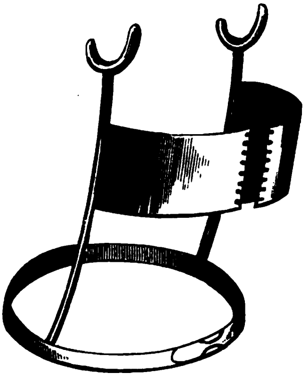
By another plan, the patient is placed in a recumbent posture on an inclined plane or couch, fixed at an angle of twenty-five degrees. The chin is secured by a silken strap; next there is placed around the pelvis a padded band, with a long leathern strap ending in a ratchet-wheel fixed obliquely at the base of the inclined plane, in a direction opposite to the uplifted hip. Another belt, formed of soft material, passes round the lumbar arc of curvature, and is fixed to the opposite margin of the plane. The arms are supported by padded crutches, also fixed to the plane, which thus secures the horizontal position of the shoulders, and affords a fixed point for the pelvis to react against when extension of the lumbar curve commences. This form of appliance was invented by the author, and has been found of the greatest possible value when used at night, after the apparatus just described has been withdrawn. It can also be adopted both by night and by day, where severe lumbar curvature has to be conquered. When placed in action the following results accrue:—First, by tightening the strap attached to the ratchet-wheel, the pelvis is drawn downwards; and secondly, the arms being sustained by crutches, and the head firmly held by a strap, an expansion of the lumbar curve ensues, which is greatly assisted and kept from retrogression by tightly securing the lumbar belt (passing across the curvature) to the side of the inclined plane. In the daytime an instrument similar to the one just figured has to be worn, or else that one, of American invention, which is figured at page 22.

FIG. 11.



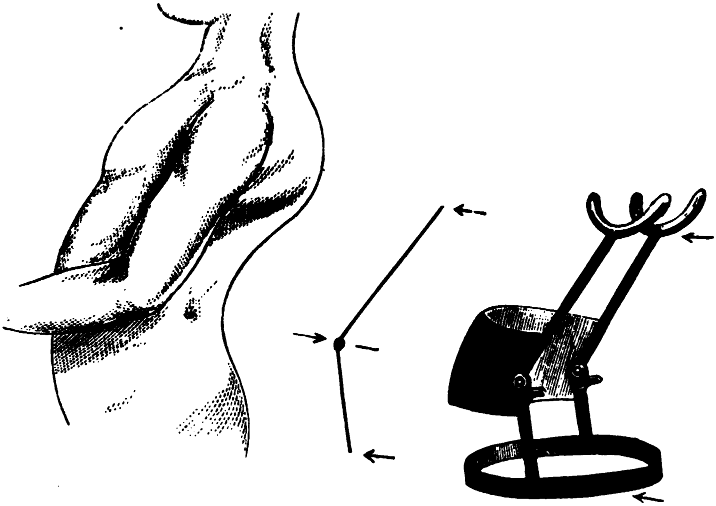
Another variety of lumbar distortion, of very frequent occurrence, is an arching forwards of the loins. This kind of curvature not only embraces the loins, but frequently extends along the whole course of the spine, forming a long arch with a deep anterior hollow. The technical name by which this variety of distortion becomes immediately recognised, is "Lordosis;" and it arises, surgically, either from tension of the longissimus dorsi and sacra lumbalis muscles, or from a lessening of the lumbar intervertebral cartilages on their posterior surfaces. Both these conditions may exist apart as predisposing causes, or they may be found combined: the latter being by far the most customary form. Patients who suffer from this kind of spinal distortion find it extremely difficult to walk or stand without throwing the abdomen forward in an unnatural and inelegant manner. The shoulders are generally rounded, by an effort made by Nature to compensate, through the muscles of the chest, for the disturbance occasioned by divergence of spinal equilibrium posteriorly. When this distortion has existed for any length of time it becomes perfectly irremediable; but for its early stages various mechanical appliances are constructed. The simplest consists of a pelvic band, with two lateral uprights, around the anterior surface of the body; across the abdomen a deep webbing band is placed, and its extremities reflected over the side uprights, and brought again to the front, where it is secured by lacing. The action of this instrument is to depress the anterior surface of the curve, and so gradually lessen the vertebral deformity.

FIG. 12.



Another form of instrument is based upon the supposition that a mechanical centre exists, around which the curvature of the spine arranges itself. This is to be found about the middle of the concavity; but as that point cannot be reached, it becomes necessary to construct the mechanism in such a manner as to let its axes agree with a line drawn transversely across the thorax from the centre of the curve to the sides of the body. Thus the apparatus acts around the same fixed point as it would have done had the vertebræ itself been more accessible. To explain this perfectly, the following diagram is given.

Fig. 13.

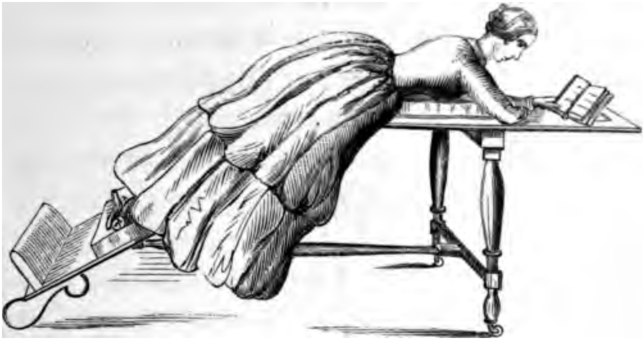


The first drawing represents a lateral view of the body affected by (Lordosis) lumbar curvature, and the asterisk is placed to determine the point where the axis of the curve is to be found. The second drawing shows the form of an instrument so arranged that its artificial axes correspond exactly with the centre of curvature.

This apparatus is formed by a pelvic band and two lateral uprights; and at the axial point, marked in the first drawing by an asterisk, a rack and pinion motion is placed. A deep webbing strap passes across the abdomen, and the arms are supported by padded crutch-heads fixed to the uprights. Upon moving the rack and pinion centres with a key, fitted to the mechanism, pressure against three points occurs: first, on the abdomen, by means of the webbing band; next, on the sacrum, through the medium of the pelvic belt; and third, on the arm-pits, owing to the resistance afforded by the crutches. The reader need hardly be told, that in seeking to straighten a curve of any kind, wheresoever situated, pressure upon its arc and expansion of its extremities must be the *modus operandi.* In the curve formed by the spine in the case just figured, the abdomen forms the crown of the arc; the posterior surface of the pelvis, one extremity, and the anterior surface of the thorax, the other. The resulting action of this instrument is therefore easily comprehended.

Another plan occasionally resorted to, is that of placing the patient on a prone-couch, similar to the following figure, and trusting that the weight of the inferior extremities will gradually redress the curve, in which it is said to be assisted by the respiratory action of the body, which, by enlarging the abdomen and extending the longissimi dorsi muscles, gradually leads to an elongation of their fibres and a removal of one of the most powerful agents against restorative efforts.

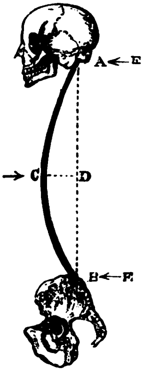
FIG. 14.



It has sometimes been suggested, that the patient should assume none but a sitting posture, under an impression that this position might facilitate the restoration of the curvature by inducing an arching backwards of the whole spine. I am however persuaded, from my own experience, that nothing succeeds better in these cases than the pelvic-band, with double lateral jointed uprights, as described at page 73.

The following formula is given in support of my hypothesis :—

FIG 15.



Let A C B represent the vertebral curve, and D be an imaginary straight line; C will be found to form the centre of the curve, having A B as its extremities.

Now, to reduce A C B to a plane parallel with D, a fulcrum must be established at C, and the extremities of the curve be drawn towards it, in the direction E E.

The fulcrum C is formed by the webbing-band. The expanding power, or leverage, is given by the uprights, which constitute two levers of the second order, having their centre at the rack and pinion.

The pelvic band and the arms, forming as they do extremities to the lateral levers, move in slight circles around the central rack and pinions, and thus gradually bring A C B into the same parallel plane with D.—Q. E. F.

In all cases where geometric or mathematical deductions are based upon changes sought to be produced in the human body, it must be borne in mind that only an approximate result is ever obtained, as owing to the softness and vitality of those surfaces against which the mechanical forces are brought to bear, the scientific actions of all instruments are immediately altered on being brought into powerful operation. Still, to render the proximate principles intelligible, it is necessary to reason as if the different structures forming the human body possessed the same power of resistance as solid metal would under equal ratios of resistance and pressure. If this concession were not made, it would be utterly impossible to arrive at even the most distant conclusions as to the action of the appliances intended to redress deformities of the human frame. When, for instance, it is stated in subsequent parts of the present work, that those centres formed by various spinal curves, are selected for points of mechanical movement in the appliances adopted, it is intended to demonstrate the existence of certain fixed points around which the remaining portions of the spinal column and its adjacent structures group themselves, and the propriety of being acquainted with these centres. But it must strike the mind of every sensible person, that the moment mechanical power is brought to bear upon an element so variable as force, in its relation to the formation of the vertebral column, the multitude of movements engendered by the distribution of resistance through the whole spine becomes so considerable, that the assumed centres only hold a relative not a positive condition in the chain of argument intended to explain the scientific treatment of spinal curvature. For all practical purposes, the centres and fixed points described in this work as existing at certain parts of the human frame, actually are to be found; but the intention of the above remarks is to show, that upon bringing mechanical forces to bear upon those centres, they will be found subject to such a degree of aberration as to no longer place them within the category of geometric demonstration, in its strictest and most critical sense. It may be asked, what, then, is the use of seeking to establish the existence of certain fixed points from which the applied mechanisms should act? The reply to this is, that unless some rule of the kind were followed, it would be perfectly impracticable to found anything like a purely scientific system for the construction of anatomical appliances. It must therefore be remembered, that in speaking of certain mathematical centres, I merely allude to points, or parts of the body closely approximating to that condition. The circumstance of lumbar curvature existing alone is beyond doubt; yet by far the larger number of cases present themselves with it in combination with other varieties of vertebral distortion.

There is one condition under which lumbar curvature is sometimes found, namely, when the bodies of the vertebræ have rotated upon their perpendicular axes. This deformity is known by a considerable prominence in the loins, sometimes, indeed, mistaken for lumbar abscess, but really constituted by the longismus and sacro-lumbalis being thrust backwards by the transverse spinous processes of the lumbar vertebræ. This helical, or corkscrew twist, is invariably found associated with dorsal displacement, and most frequently with pelvic derangement.

It is mechanically treated by the application of an apparatus formed of a pelvic belt and two lateral uprights, having a posterior stem with a plate resting upon the arc of curvature. But instead of the plate possessing lateral action alone, as in the instrument for lumbar curvature, described at page 68, it is furnished with a horizontal rack attached to the plate and moving on its parallel axis. The advantage resulting from this arrangement is, that it produces pressure in an anterior direction by means of the horizontal rack, and in a lateral direction by the ordinary sacral centre. These two motions, judiciously combined, produce a third, as the resultant of both, which acting in the same direction as that in which the spine was originally curved, gradually unfolds the helix and restores the spine to its normal position. An immense amount of importance was attached, some years since, to this peculiar condition of rotation, and I invented a series of *movements* attached to the plate of an ordinary spinal instrument, by means of which the spine became acted upon in as many planes as there had previously been directions of distortion. The ingenuity exhibited in this device led to its general adoption, without, as frequently happens, any credit whatever being given to its real inventor. The gratification I derived, however, from the knowledge that it revolutionized the treatment of spinal curvature, has amply rewarded me for the pains bestowed upon the scientific requirements of the apparatus.

Previous to the invention of this innovating combination, it had been usual to act upon the spine either in a purely lateral, or an anterior direction; but as the force exercised laterally was invariably negatived by that adopted anteriorly, the whole system of treatment resulted in nothing.

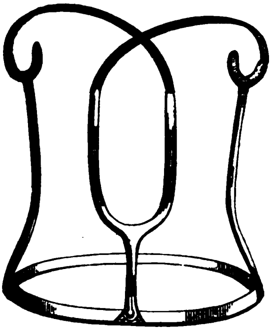
By combining each plane of force in a series of common-centres, the problem became solved, and the restoration of spinal curvature, despite of axial rotation, at once satisfactorily established. *Palmam qui meruit, ferat* is a very trite and valuable apothegm, the direct application of which is but too frequently neglected in the busy and competitive world of science. In another part of this work a full description is given of this instrument, as constructed for overcoming severe lateral curvature, accompanied by axial rotation of the bodies of the vertebræ, and it is earnestly recommended to the perusal of those who find pleasure in ingenious mechanisms.

Posterior curvature of the lumbar vertebræ is another malady affecting this region, and may be proximately due either to disease in the bodies of the vertebra, or to relaxation of the posterior spinal ligaments. In the former case, it is distinguished by a sharp angular prominence, like a knuckle, and is sometimes accompanied by considerable tumefaction on one or both sides of the column. It resents any pressure being made upon the arc of curvature or its adjacent region, and, unless arrested, increases with a considerable degree of rapidity.

This variety of distortion offers a clear illustration of the importance due to a surgical knowledge of the condition existing prior to the adoption of any apparatus. If powerful pressure were employed on the arc of curvature, in a case of diseased spine, not only would considerable pain be engendered, but all the symptoms accompanying the curvature would be greatly increased. If the patient had a strumous diathesis, as in nine cases out of ten she certainly will, then the formation of lumbar abscess might be stimulated, and incalculable evils accrue. But where a correct diagnosis of the case is presented to the mechanist's mind, either by his own personal experience, or that of the medical adviser of the patient, a mild and effective system of treatment will be secured. The instrument devised for these cases consists of a pelvic band, with two lateral sliding uprights, and a bifurcated vertebral stem, governed in its action by a rack and pinion centre, acting in an anterior direction. Over the arc of the curve, a soft chamois leather pad is placed, while the arms of the bifurcated stem rest gently against the angles of the ribs, and the heads of the transverse spinal processes.

The rack and pinion is simply employed to secure apposition, not pressure.*

FIG. 16.



Upon the application of this instrument, the lumbar vertebræ are held in a perfectly steady and immovable position, whilst the apex only of the curve bears the slight pressure of a soft pad. Diseased action would thus soon cease, according to the law established by Mr. Hilton, that all diseased surfaces and structures require for their renewal of healthy action absolute physical rest.

In Germany and Austria, and also in many parts of England, it is usual to place patients who are labouring under diseased lumbar vertebræ in a recumbent posture, under an impression that rest is more easily obtained in this position than any other. Reflection will, however, soon enable us to see that the vertebræ are far more likely to be disturbed by restlessness such as must ever be induced by the constant maintenance of so restrained a posture, than when firmly secured by the appliance which I have mentioned. In addition to which, no objection exists to placing the patient who wears such an appliance in a recumbent position, if necessary.

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* This instrument has met with the approval of, and been adopted by, Mr. Erichsen, Mr. Fergusson, Mr. Hilton, Mr. Paget, Mr. Tatum, and other leading surgeons.

When this combination of treatment is adopted, the best kind of rest is obtained from the use of an American chair, so constructed as to afford an opportunity of varying the angle at which the patient reclines; for although it seems paradoxical to declare that the purely horizontal posture is the one of the least actual rest, it can, nevertheless, readily be proved that it is so.

The human spine it is well known consists in its natural condition of three arcs of curvature, one at the neck, formed by the cervical vertebræ and arching inwards; a second at the shoulders, due to the dorsal vertebræ, and bending outwards; the third at the lumbar or loin region, and like the cervical curve, of which it forms a complementary element in maintaining equilibrium, arching inwards. Now when the body is placed in a purely horizontal position, as upon a hard board or the floor, the concavities of the lumbar and cervical curves are not only unsupported, but materially increased by the projection of the base of the head and the gluteal muscles, or buttock. Thus those muscles and ligaments which lie in the hollow of these arcs are kept in a continual state of tension and irritability, being the very reverse of what is intended—viz., rest. But if, instead of the body being placed perfectly horizontal, it is laid upon an inclined surface, so prepared that the curves of that surface exactly fit in with those of the human spine, then rest in its most perfect condition is gained. To secure this great desideratum, I have had a chair constructed* in such a manner, that the padding forms an exact counterpart of the shape of the spine; and to prevent this from being at all disturbed by wear or weight, a small hidden board is so placed at the back of the padding as to always maintain the exact shape originally given to it, and this must be differently arranged for each patient. Not only can the chair itself be placed at any semi-recumbent angle, but it may, if required, be made to assume a horizontal condition, without for an instant sacrificing the advantage of form just specified.

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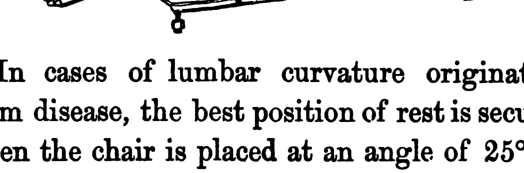
* Sold by Ward & Co., 6, Leicester-square.

This chair is suitable for every condition of spinal disturbance, and in cases of mere muscular debility, tends as much to prevent curvature as to support the arch, should it unfortunately arise.

FIG. 17.



In cases of lumbar curvature originating from disease, the best position of rest is secured when the chair is placed at an angle of 25°.

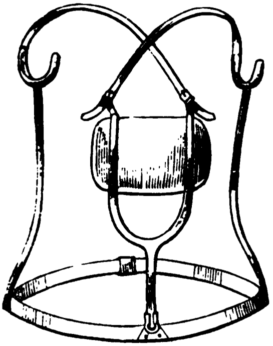
Curvature of the lumbar vertebræ without diseased action is by far the most frequent condition. This, as I have already mentioned, results from relaxation of the posterior ligaments of the spine, and compression of its anterior intervertebral surfaces. It exhibits an arched surface, which is without any tenderness, and has an equal enlargement of muscular substance on either side. The margins of the lower ribs are compressed against the abdomen in front, and the whole body assumes a stooping posture, such as is seen in ordinary relaxation of muscles and ligaments from old age.

The mechanical appliance devised for this form of curvature consists of a padded pelvic band and two lateral uprights. To the back of the pelvic band, at its sacral surface, a bifurcated lever is attached, acted upon by a rack and pinion centre; but instead of the bifurcation supporting both sides of the curve, as in that figured at page 84, it terminates in a padded metal plate, resting upon the curve just *below* the axis of posterior deviation, or, in other words, pressing upon the lower segment of the arc described by the lumbar vertebræ. The reason for its being placed below the vertex or highest point of the curve, instead of directly upon it, is readily understood when the action of the instrument is carefully examined.

The curve being attributable to a leaning forward of the bodies of the lumbar vertebræ, necessitates a corresponding yielding of the upper portion of the thorax, which, although not actually curved in an anatomical sense, adapts itself to the general yielding, in order to maintain the head in equilibrium with the remaining parts of the body. On applying the instrument, if the padded plate were placed where, by the way, nine persons out of ten naturally adjust it, on the arc of the curve, it would tend to still further disturb equilibrium, or balance, by throwing the body more forward; but if placed, as I suggest, immediately below the axis of curvature, the reaction of the arm-piece of the instrument against the thorax of the patient tends materially to unfold the curve.

In these cases it is hardly possible to make too much pressure against the spine, the only limit being the chance of injuring the integuments or tissues stretched over the prominent spinous processes. The plate is, however, hollowed so that not only is this danger avoided, but advantage results from the force exercised against the transverse processes of the vertebræ and the angles of the ribs.

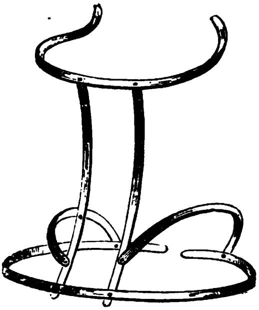
FIG. 18.



These two appliances are intended for cases that can bear ordinary support or pressure, but occasionally some condition arises in which neither can be borne. It is then customary to use an instrument of the following form, which leaves the spine entirely free in its whole course.

It has the universal pelvic band, but instead of the usual concomitants, "lateral uprights," two vertical stems, shaped to the external contour of the spine, rest against the angles of the ribs, and are surmounted by a padded bar carrying two horizontal sliding arm-rests. The instrument is also prevented from falling downwards by hip-bands passing over the spinous process of each ilium.

FIG. 19.



The use of this appliance undoubtedly at once explains itself; suffice it to say, that by establishing extension between the arms and pelvis, in combination with a certain amount of rest afforded to the spine by the vertical stems, the whole column is kept in a state of inaction, which, in cases of spinal irritability or disease, is the main point to be looked to. In infantile cases, the plan adopted is that of carefully moulding a gutta percha splint to the whole posterior surface of the thorax. This constitutes a kind of trough, so carefully attached to the little patient's body as to prevent any chance of injury to the spine, by an accidental fall or movement.

These appliances are but a few out of the multitude employed in the treatment of lumbar curvature. As it is impossible, not only to give a description of the large number of different instruments constructed for this kind of deformity, but even to enter fully into the practical details of those that are figured, I will most willingly afford to any medical man who feels desirous of further understanding their structure, a full and particular explanation of the mechanical laws involved in either.

CHAPTER V.

DORSAL CURVATURE.

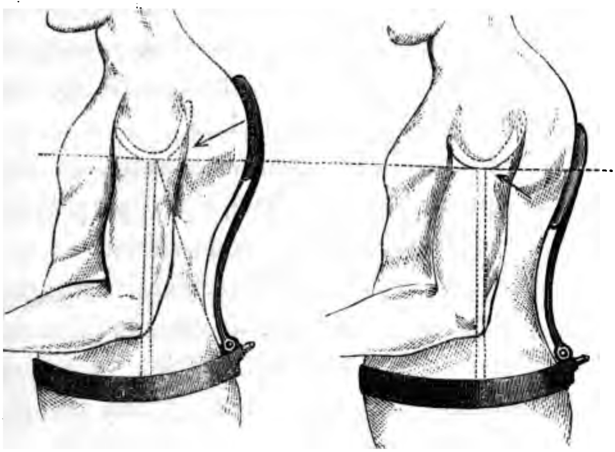
In the last chapter I gave a description of those appliances which are best calculated to ameliorate distortions of the lumbar vertebræ, or loins. I have now to consider what special mechanism exists for combating such forms and conditions of spinal curvature as particularly relate to the dorsal region.

Dorsal curvature may be divided into three distinct conditions, which derive their names from the resulting deformity: viz., posterior or cyphosis, anterior or lordosis, and lateral or scoliosis. When the spine yields in an outward direction it is called cyphosis, and presents an arching backwards of the whole dorsal region. This name strictly applies to the deformity when it is uncomplicated by the presence of caries or osseous disease, but arises simply from a relaxed condition of those ligaments and muscles whose function it is to hold the column erect.

It need hardly be stated that when these substances are unduly lax, or lengthened, a leaning forward of the spine ensues, with anterior compression of the intervertebral cartilages, the effect of which is to disturb the equilibrium of the column, and lead to the formation of a posterior curve. The premonitory sign of this deformity is a constant sense of aching or weariness in the loins, accompanied by inability to sit perfectly erect for any length of time without engendering pain. Finding that any attempt to hold the spine in its natural position creates physical inconvenience, the patient is almost involuntarily led to use soft cushions and hollow-backed easy chairs as the most agreeable means for obtaining rest. This however, unfortunately, only serves to increase the deformity still further, by an approximation of the superior and inferior extremities of the curve, and an extension of the posterior spinous ligaments. When the spine has attained this condition it necessarily follows, that when the patient is in the act of standing or walking, the weight of the head and upper extremities carry them in a forward direction, much beyond the gravital line as established normally between the base of the skull and the pelvis ; and it is to restore their equilibrium that a posterior curve is created. The mechanical treatment of this peculiar condition of deformity needs far greater judgment than is ordinarily supposed, even by those who have the surgical care of these cases, for, owing to the formation of the upper segment of the curves embracing so large a portion of the trunk, any attempt to produce amelioration must be founded on the following principles, or otherwise, an increase, instead of diminution of the distortion will take place.

When the body arches forwards in the manner previously described, the upper portion of the curve induces a compression of the anterior surfaces of the intervertebral cartilages, and places each vertebra above the axis of curvature in an oblique position, with an antero-inferior direction. This greatly favours the chance of increasing the deformity should pressure of any kind be made, either upon or above the centre of the curve. For if the force so applied rested against the highest point of the curve, it would have an immediate tendency to throw the whole body forward, whilst if it were applied above this point, then a compression of the curve upon itself, in a downward direction, would ensue. In both instances the patient must be harmed. But if, instead of making the mechanical resistance act against either the centre—which is almost invariably done—or the higher segment—which almost as frequently happens—the support is placed at least two vertebræ beneath the axis of distortion, then a highly satisfac-

FIG. 20.



tory result is gained by expansion of the extremities of the curve and consequent depression of its arc. To explain this more clearly the annexed diagram is given.

In the first figure the spine is exhibited in its distorted position, with the artificial mechanical power presented by an ordinary spinal instrument resting above the axis of the curve.* The dotted line that passes from the pelvic centre of movement pertains to the mechanism, and is found to be a radius of the circle formed when the pad of the instrument is set in motion. By studying the direction taken by the periphery of this circle, it becomes apparent that the spine, if it yields at all, must do so in an anterior and downward direction, which is highly calculated to increase the distortion.

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* It may be necessary to remark that the form of the spinal instrument here supposed to be adopted, is that ordinarily used in such cases, consisting of a padded pelvic band, with two lateral arm rests and a vertebral plate, resting upon the arc of curvature. This plate is governed in its action by a ratchet centre fixed at the back of the pelvic band, the object of which is creation of pressure against the curve, and consequently, reaction from the arm rests, which, in this instance, should always be rigidly attached to the lateral surface of the pelvic band.

In the second figure the pad of the instrument rests beneath the axis of curvature, and the same form of dotted line being used to show the direction of force, it will be seen that the curve must of necessity expand upon pressure being made on its lower segment, and resistance obtained in favour of its upper portion, by the axillary crutches, which, by the way, in the former illustration, only tend to negative the action of the plate; not sufficiently so, however, as to destroy the mal-effect of the false application of mechanical power.

The practical rule in all these cases of posterior dorsal curvature, unaccompanied by disease, is to carefully place the pad beneath the centre of the distortion; let the arm crutches be sufficiently high and oblique to act backwards against the axillæ, and secure the instrument from slipping downwards by a well-fitting pelvic adjustment. Under these conditions the greatest good can be gained by the careful expansion of the vertebral curve, which is sure to result when the force of the posterior plate is gradually increased; and this can be done by moving the ratchet in a forward direction.

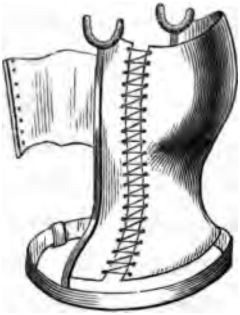
Posterior curvature also frequently results from that condition known as "Pott's disease," or destruction of the bony substance of the vertebræ. This is generally distinguished in contradistinction to ordinary cyphosis by one or more of the spinous processes becoming sharply prominent, and presenting the appearance of a knuckle; hence it is sometimes called angular. When hardly pressed, pain, either at the angle itself or in the immediate neighbourhood, results. Thus the mechanical conditions presented by this variety of spinal distortion differ considerably from those of the deformity last treated on, as any attempt to make the same amount of pressure below the axis of curvature would lead to most disastrous results. This, probably, more than anything else, furnishes a powerful argument as to the necessity there always is for the treatment of spinal curvature never being attempted except under sound surgical advice. Since the cure of deformities has become a recognised branch of surgery, but little chance exists of those errors being perpetrated which occasionally resulted from injudicious mechanical treatment. It is preeminently the duty of every patient who labours under any vertebral malady, to seek the best advice they can obtain from the surgeon, and similar assistance from the mechanist. If, however, the latter be incapable, from want of knowledge or from imperfect education, of perfectly comprehending those protean changes that arise from surgical, physiological, or mechanical causes, he is utterly incompetent to perform his true *rôle*, that of an able coadjutor to the surgeon. As professional etiquette renders it impossible for a medical man to devote himself to the construction of orthopædic instruments, so is it highly necessary that whoever undertakes the task in a scientific spirit should possess all the attributes necessary for the fulfilment of so important a position. Disguise it as you will, without highly scientific mechanical aid the skilful treatment of deformities is impossible. The recognition of this truth becomes each day more certain.

The spinal instruments adopted for posterior and angular curvature are few in number;

those for distortion unaccompanied by disease will be first described.

In cases where the distortion exists in young children, or is but of slight extent in adults, the simplest form of support consists of a leathern shield, carefully moulded to the back, and furnished with lateral supports beneath the arms; without which any attempt to support the spine is useless. A soft band passes across the front of the chest and prevents the body from slipping out of the apparatus. This shield should be so constructed as to support the curvature beneath its apex, whilst the surface above it remains free. Its form and the manner in which it should be applied are figured in the following drawing :—

FIG. 21.



When the distortion has become strongly

marked, and much deviation from the perpendicular has resulted, the best form of appliance will be found to be a padded pelvic band, with two sliding lateral supports, having a laced band passing over the front of the sternum. At the posterior centre of the pelvic band a vertebral stem, accurately curved to the shape of the back, should be fixed, with a padded plate, corresponding in shape to the lower segment of the curve attached to it. At the base of the vertebral stem a rack and pinion centre is placed, for the purpose of admitting of a perfect regulation of the pressure produced by the plate upon the spine. The mechanical action of this instrument is threefold. First, it takes off all weight from the spine, by means of the lateral crutches. Next, it affords perfect rest and support to the yielding vertebræ. And thirdly, it diminishes the deformity by expanding the extremities of the curve and depressing its centre. This effect results from the pressure made by the plate upon the lower half of the curve, and the reaction established at the arm pieces against its upper portion. This form of instrument is represented at Fig. 20.

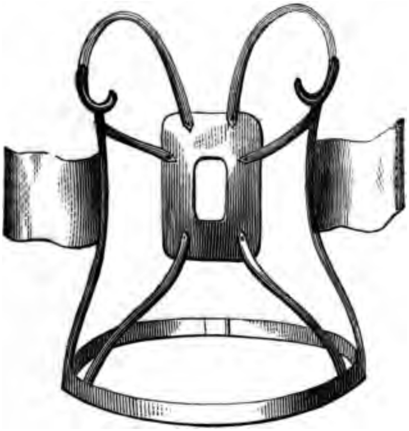
Another form of support consists of a bifurcated lever, resting against the transverse processes of the vertebræ. This, however, is only adopted in cases where the spinous processes are incapable of bearing pressure. Its mechanical effect is precisely the same as that of the padded plate. A drawing of this form of appliance has already been given at page 96; the only difference being that it is there adjusted for posterior lumbar curvature.

These are the appliances usually adopted for posterior curvature, unassociated with disease; but where caries exists other forms are usually employed.

Amongst the first of these is an instrument formed by two lateral uprights and a pelvic band. To the posterior margins of the lateral supports four buckles are fixed, which give attachment to a carefully prepared pad, made of soft leather and so arranged that the lower edge shall have a sphenoidal, or wedge-shaped, stuffing, the reason for this being, that the curve should be supported just as by the plate apparatus previously described; but not so rigidly.

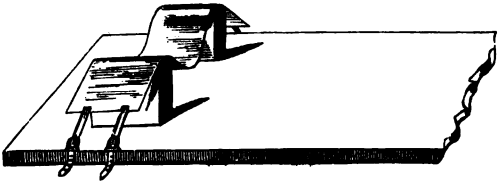
Although, apparently, a very minor matter, the utmost importance attaches itself to the manner in which the straps are fixed. They should be so arranged that the two lower straps may create a supporting, and oblique, surface for the spine to rest against, whilst the two upper ones will simply keep the pad *in situ*. Without this precaution the treatment might become mischievous, by inducing mechanical pressure in the wrong place, and in a faulty direction.

FIG. 22.



A plan which I found pursued very extensively in the neighbourhood of Vienna, is that of placing the patient on a couch, so prepared that a webbing band receives the weight of the patient, who reclines in the prone position (face downwards). This band is stretched between two fixed lateral rods, and very properly passes above the axis of the curve, and across the upper part of the sternum; its action being the reverse of that sought to be obtained by the use of the back pad, or plate. The disadvantage attached to this mode of treatment is, that of keeping the patient constantly confined to one position. It has, however, very powerful advocates on the Continent.

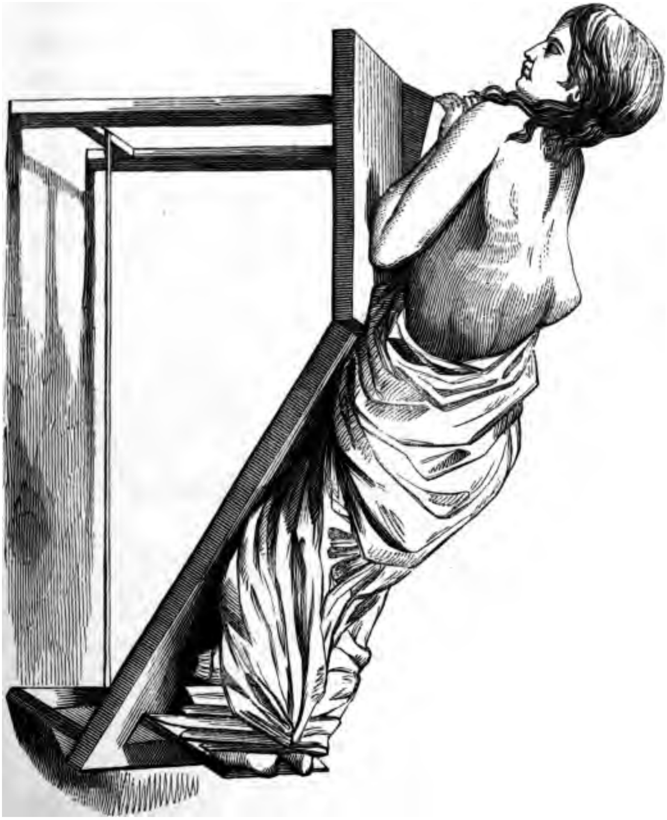
FIG. 23.



In these cases occasionally a padded plate of light construction is adopted; but its effects are uncertain, and not comparable in value with the hollow pad mentioned at page 104.

It has also been the custom in London to place patients affected with angular curvature in a prone position; for which purpose several highly ingenious couches have been invented. The one best known, and most used, is that called "Verralls," which is here depicted.

FIG. 24.



The mechanical theory sought to be enforced by this arrangement, is that of removing the superincumbent weight of the head and shoulders from the spine, whilst the lower extremities and pelvis, being placed on an inclined plane, tend by their mere weight to slightly expand the curvature, without increasing the chances of an increased amount of destructive osseous inflammation.

In one and all of these "orthopædic," "orthorachitic," "prone," and other hard-worded couches, the prevailing idea is the imparting perfect rest to the diseased vertebræ. It is, however, an indisputable fact that a portable apparatus, when carefully adjusted, gives much more actual rest to the spine than any of these devices, and with this signal advantage, that a patient's health does not suffer physical injury, or his mind unnatural debility from a monstrously protracted state of forced and unnatural inactivity.

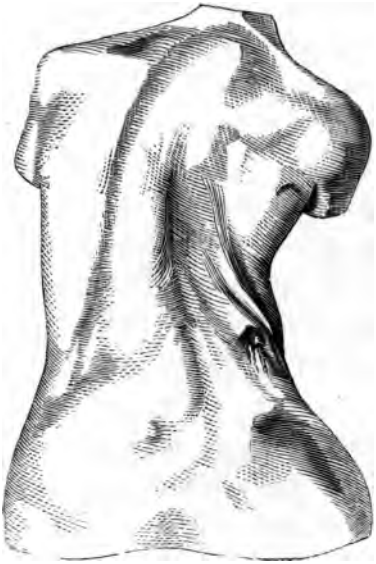
The next form of distortion presented by the dorsal vertebræ is termed "lateral," from its involving an arching sideways of the vertebral column in the dorsal region.

It may, however, be taken for granted that a strictly mathematical lateral dorsal curve hardly ever exists; it is either combined with deflection of the lumbar, or blended with deviation of the cervical region.

I have only seen three clearly marked cases of a single dorsal curve in all my experience, and these were entirely due to diseased action having produced partial exfoliation of the ribs on one side of the body. The distinguishing features of dorsal curvature, in these exceptional cases, are an approximation between the armpit and hip on one side of the body, with an enlargement of the ribs on the other, accompanied by uplifting of the scapula, or shoulderblade. This enlargement is produced by a separating of the oblique and transverse processes of the spine, and is said to be due to an uneven compression of the intervertebral cartilages, with diminution of the osseous substance at those portions of the bodies of the vertebræ which are situated in the concavity of the curve. In one of the cases, where this deformity existed in its most marked form, the margins of the ribs completely overlapped each other on the right side of the body, whilst the left shoulder and side formed an arc, having its extremities in the pelvis and cervix, and its centre in the bodies of the fifth and sixth dorsal vertebræ. The left scapula had become so much displaced that its inferior angle rose to within half an inch of being on a level with the axilla on that side. It is needless to say that the whole thorax exhibited a very contorted appearance.

Notwithstanding the severity of these rare cases of vertebral deformity, several apparatuses

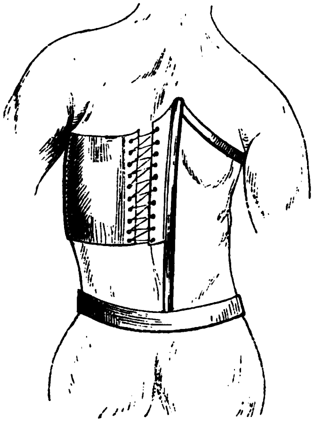
FIG. 25.



have been devised to meet their requirements. The first consists of a padded pelvic band, surrounding the hips, with two perpendicular levers, one in front of the thorax, the other behind it. The preceding sketch exhibits the condition presented by this variety of spinal curvature.

A webbing band, passing over the costal, or rib projection, connects the back and front stems together, and by well-regulated pressure gradually reduces the curvature. Under the armpit, opposite to that of the curvature, a padded crutch is fixed, which forms a connecting band between the back and front stems,

Fig. 26.



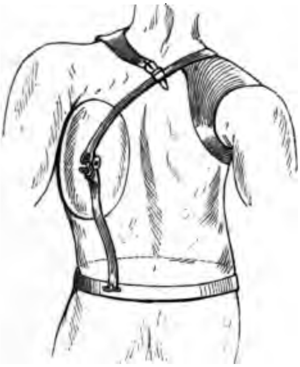
and affords a mechanical point of extension between the pelvis and the scapula. The object of this apparatus is expansion of the concavity, and compression of the arc of a pure dorsal curve.

Another kind of instrument applicable for these cases is formed as follows:—

A padded belt encircles the pelvis, having at its lateral extremity a curved metallic stem. One instrument possesses at its centre a rack and pinion movement: just beneath this rack joint a steel plate is fixed, which is capable of adjusting itself to the arc of curvature by a hinge joint. The upper extremity of the side lever terminates in a padded arm-loop, which, when carefully adjusted, takes its bearing against that side of the thorax on which the concavity of the curve is situated. The means by which this instrument is brought into action may be rendered intelligible by the following diagram.

The padded plate belonging to the rack and pinion stem, it will be seen, rests on the arc of the curvature, whilst the padded arm-loop embraces the opposite side of the shoulder. Upon moving the rack and pinion centre, an uplifting of the arm on the right side ensues, combined with an increase of pressure against the ribs of the left side. Thus the same effect is produced upon the spine as occurs when a curved stick is straightened by placing its highest surface against the knee, and pulling at its two extremities with the hands.

Fig. 27.



Seeing that in these cases a very great amount of disturbance to health arises, from such compression as the contracted ribs exercise upon the lungs, it becomes a matter of paramount importance to resort as early as possible to mechanical aid.

Although it has long been stated that a

single curve rarely exists, yet many appliances intended for the treatment of lateral curvature have evidently been constructed under the fallacious notion that but one arc of deflection has to be dealt with. Amongst those particularly framed on this supposition, may be mentioned the lever belts of Hosard and Tavernier, the spinal apparatus of Lonsdale, and the single plate instrument so frequently adopted. In all these the principle of seeking to antagonize the curve, against which mechanical power is being exercised, by a force acting in an opposite direction, has been quite overlooked. It necessarily follows that in one and all of the appliances just mentioned, the power called into operation for redressing the curvature chiefly expends itself in the establishment of a second deflection, far more difficult to cure than the first.

This subject will, however, be treated at some length when double lateral curvature and its mechanical appliances are considered. Here it will suffice to say, that whenever a double curvature of the spine exists, and pressure is made only on the arc of one curve, increase of the secondary distortion must inevitably follow.

CHAPTER VI.

CERVICAL CURVATURE.

THE HEAD AND NECK.

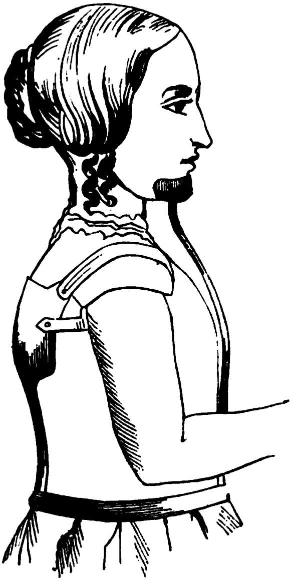
THIS vertebral distortion particularly pertains, as its name implies, to the region of the neck. Its leading mechanical characteristic is a displacement of the head from its ordinary position. Upon a careful examination, it is usually found that the head owes its change of place to the existence of one or more arcs of curvature in the cervical vertebræ, accompanied by structural shortening of muscular substance, for although the space occupied by the cervix is comparatively small, yet owing to the extreme elasticity possessed by the intervertebral cartilages, and also to the absence of any lateral support, beyond that afforded by muscular tension, curvature of this portion of the vertebræ is of frequent occurrence, and leads to the production of two, three, or more centres of deflection. This deformity is also occasionally complicated by the presence of caries, a disease of the bodies of the vertebræ, when much pain and suffering are generally present. For the treatment of either condition various mechanical appliances have been devised, which I shall now describe in their mechanical sequence, as well as in relation to the special form of the distortion which they are intended to encounter.

The simplest known distortion of this kind is anterior curvature, which betrays itself by an arching forwards of the head and a posterior rotundity of the upper portion of the shoulders.

The instrument used to redress this deformity usually consists of a leathern backboard, attached to the shoulders, and a chin-rest placed in front of the chest or sternum.

When the case is slight, this plan fulfils its purpose as well as any more complicated piece of mechanism; but should contraction of the pectoral muscles have taken place, then the backboard and collar is incapable of expanding them, and a more extensive apparatus becomes necessary. As the backboard and collar once held a high place amongst orthopædic expedients, a drawing of it is appended.

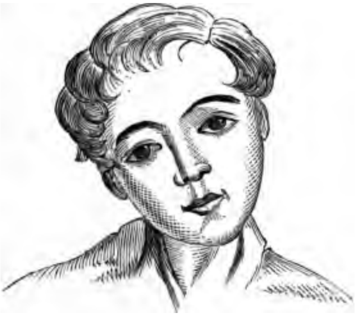
FIG. 28.



It will be seen that a padded plate rests against the scapulæ, whilst the arms are held backwards, and the chest is expanded, by shoulder caps fixed to them. Beneath the chin a small plate, curved to the shape of the anterior surface of the neck, receives the weight of the head, and prevents any yielding of the cervical vertebræ. Around the waist a leathern band passes, which serves to give connexion to the chin support in front, and to the shoulder plate behind. Greatly as this form of appliance has been ridiculed by modern orthopædists, there cannot be the least doubt but that the ladies of the last generation owe their superiority of form very largely to the daily use of this simple mechanical arrangement. It is now, however, classed with the things of the past, and rarely resorted to except upon the female members of some family which still clings to the traditional backboard and collar of former days.

The next form of neck distortion is that which arises from lateral deviation of the cervical vertebræ, and is generally accompanied by contraction of the muscle known as the sterno-cleido-mastoideus, which muscle arises from a bony protuberance just below the back of the ear, and is inserted into the clavicle or collar bone, and the sternum or chest bone. The effect of this retraction is to render the force oblique—to induce rotation of the back of the head—and to produce that distortion called torticollis, or wry-neck. The object, therefore, sought to be gained by mechanical agency is that of first rotating the head on its axis, and then gradually causing

Fig. 29.



it to assume a vertical position, instead of the oblique direction presented by the deformity. Probably no problem is more difficult for the mechanician to solve than that of effectually controlling the head, and acting upon the cervical vertebræ. Independently of the fact that the head presents a spheroidal surface, naturally of a disposition to rotate within any mechanism arranged for its retention, is the almost insuperable obstacle of the patient's fears that whatever is applied to the head must necessarily attract attention. To such an extent is this latter objection carried, that I have frequently found myself trammelled by most stringent conditions as to the concealment of the apparatus, when the first point to be established was how to hold the head at all. By dint of ingenuity and care the generality of contrivances are now so constructed as to be hidden by the hair or easily arranged beneath a fashionable head-dress. There are, however, cases of such gravity that appearance is necessarily sacrificed to utility.

For wry-neck several apparatuses have been invented, the most valuable of which is now illustrated.* It consists of a padded pelvic band, having a vertebral stem with horizontal arm-pieces. At the superior extremity of the vertebral stem a neck lever is fixed in such a manner as to be attached or detached at will. This neck lever is very peculiarly formed, being so curved as to pass around the centre of the skull, and take its bearing against the temporal bone on that side towards which the head is deflected, whilst a horizontal lever rests against the inferior maxilla, or chin bone, on the opposite side. The forehead, or temporal lever, has a vertical axis, moved by a

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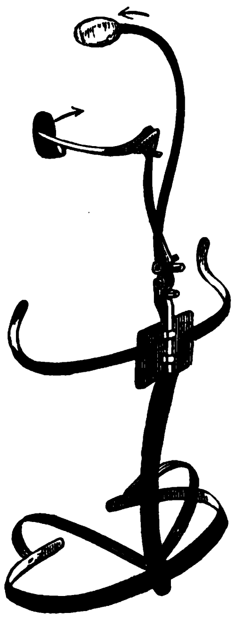
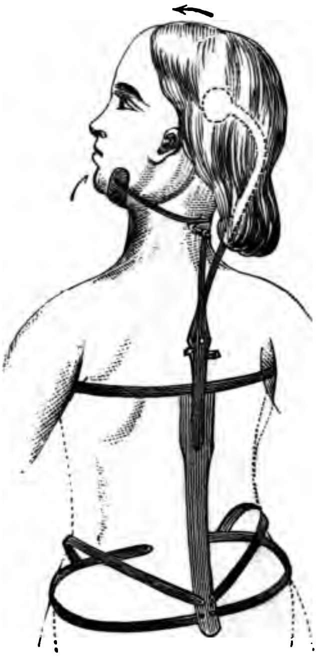
* The author first invented this apparatus for a patient under Mr. H. C. Johnson's care, in St. George's Hospital, in whose case it answered perfectly. It has since been adopted in a large number of instances with great success.

FIG. 30.



ratchet joint, upon turning which the head is gently pressed from right to left, whilst the chin, or maxillary lever, has a horizontal motion, which rotates the head upon its vertebral axis. The conjoined action of these two forces replaces the rotated chin in the mesial line of the body, and restores the vertical position of the head by expanding the sterno-mastoideus muscle.* Displacement of the head with this apparatus is utterly impossible, and the author, whose invention it is, has

FIG. 31.



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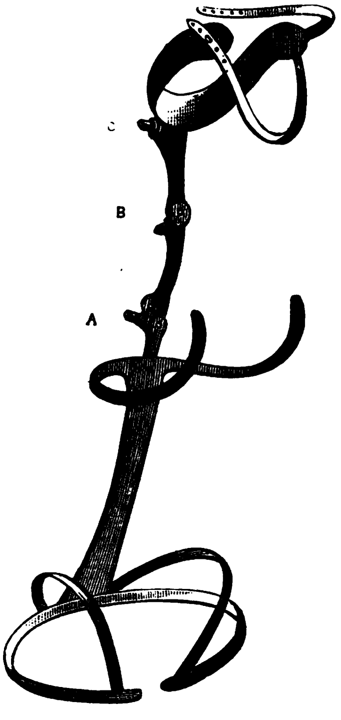
* I have given drawings both of the instrument and its appearance when applied, in order to render as intelligible as I possibly can, its *modus operandi.*

found that it secures the anatomical and mechanical conditions required in a manner far superior to any other form of instrument. For a similar purpose another form of instrument has long been employed;* but it is open

FIG. 32.



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* This apparatus is the one used at the Orthopædic

to the objection that the head can, without any very great effort, displace itself within the mechanism, unless constantly watched by the person who has charge of the apparatus. Its construction is shown on the preceding page.

A pelvic band surrounds the body; a vertebral stem supports two arm-pieces, which pass beneath the axilla. At the upper margin of the vertebral stem there is a head lever, with three distinct centres of movement; A, travelling in a lateral; B, in an antero-posterior; C, in a rotary direction. A padded metal plate rests around the occiput, or base of the skull, and the head is secured to it by a forehead and chin-strap.

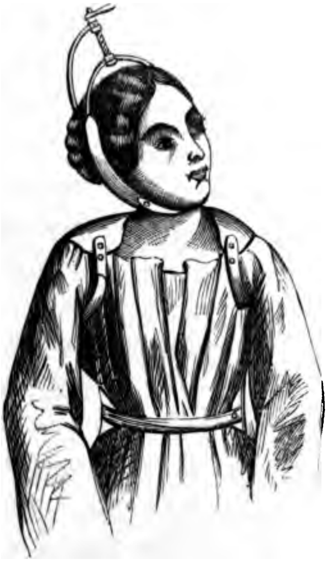
The use of this instrument is frequently adopted in cases where division, by tenotomy, of the sterno-cleido-mastoideus muscle has been resorted to, for this operation greatly facilitates the mechanical treatment, and considerably diminishes the period ordinarily occupied in redressing wry-neck.

An extremely ingenious appliance for cervi-

Hospital, but from the head easily displacing itself within the mechanism, considerable objection arises against its adoption in private practice.

cal curvature is depicted by Bonnet, a copy of which is here appended. It consists of a gutta percha shield fitted to the back, at the upper margin of which an arched piece of metal, with a double-action ratchet centre is attached, which

FIG. 33.

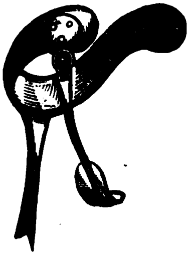


consequently possesses lateral and antero-posterior movements. To the extremity of this curved steel rod a double plate, resting on each side of the face, and governed by a simple screw, is fixed. When this instrument is applied the head can be readily moved in any required direction. In ordinary cases it would answer its purpose particularly well; but should there be much sterno-mastoideal retraction of the neck, then such an apparatus would be liable to fail, owing to the base of the head not being sufficiently controlled.

Finding that the plan mentioned at page 122 is constantly inefficient, I have devised a modification which gives far greater control over the head. This arrangement depends upon the presence of a vertical lateral lever, fixed to the anterior extremity of the occipital band, on that side of the head towards which the chin rotates; furnished with a ratchet screw, acting in a vertical plane with the face, and inducing pressure against the chin, with consequent rotation of the head and face. Although it appears to be but a trifling addition to the old-fashioned form of apparatus, yet its results are highly important, from entirely checking displacement of the head within the instrument.

Cervical distortion is also occasionally met with after burns, caused by powerful contraction of the scars or cicatrices, which thus produces deformity of the head and neck. The ordinary condition in which this variety of displacement is met with presents an approximation between the chest and the chin, with slight vertical rotation of the face. I have invented two especial forms of apparatus for these severe cases.* The first instrument con-

FIG. 34.



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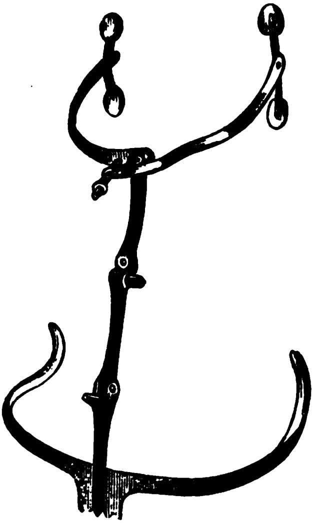
* These apparatuses were first applied to two patients under Mr. Timothy Holmes' care, in the Children's Hospital, Great Ormond-street.

The first instrument was intended to expand the cicatrix, by raising the chin from the chest, and then extend the contracted muscles, by giving lateral vertical action to the head.

The second instrument had a far more difficult task to perform, viz., to hold the under lip firmly whilst extending the chin from the chest. Both objects, however, were perfectly secured.

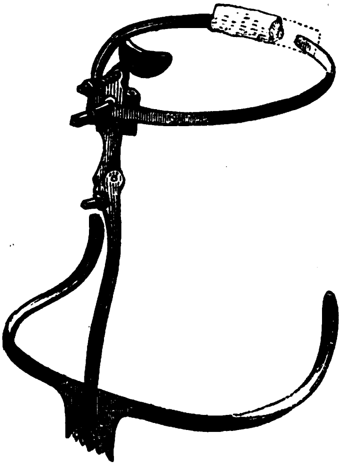
sists of a padded pelvic band, with vertebral lever and horizontal arm-rests. To the upper surface is fixed a head stem, with two rack and pinion movements: one vertical, and corresponding with the obliquity of the face; the other horizontal, and agreeing with the rotation of the head. The latter rack and pinion movement forms a centre for two levers passing along either side of the head, and holding vertical springs resting against the temporal and maxillary bones. On attaching this instrument

FIG. 35.



the action of the vertical rack gently raises the chin from the chest, whilst the horizontal one tends to press the two side springs firmly against the head, and prevent its escape from the mechanism. The second apparatus is of still more novel construction, having, in addition to uplifting the chin from the chest, to press with some considerable degree of force against the cristamentalis of the inferior maxillary bone, in order to prevent the lower lip from being drawn downwards towards the sternum while the head is gradually raised. Its construction is as follows. It possesses a

FIG. 36.

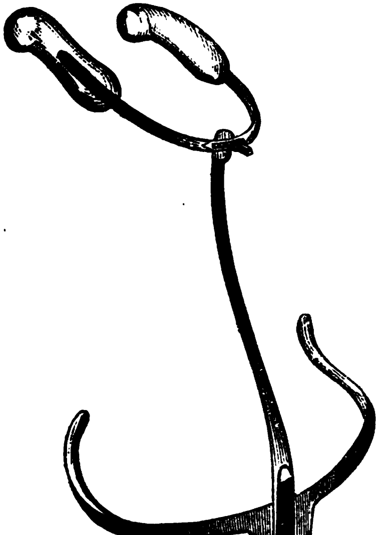


pelvic band, back lever, and arm-pieces. To the upper surface of these arm-pieces a stem is attached, having a vertical rack for uplifting the head; above this are two arms moving on a hinge. The anterior extremity of these arms enters a small metal pad, formed to rest against the front of the chin. On the occiput a plate rests, which can be pressed against the back of the head by turning a small screw, and thus engendering pressure between the base of the skull and the inferior maxillary bone. When this is firmly arranged, movement of the vertical screw at once uplifts the chin, and separates the retracted lip from the chest.

In both these cases cervical curvature existed as a sequence to the displaced position of the head; and consequently became ameliorated in proportion as the chin was restored to its natural position.

Another form of cervical distortion is where, either from disease in the anterior surface of the vertebral bodies, or paralysis of the posterior muscles of the neck, the head falls helplessly forward, and requires the assistance of the patient's hand to hold it in a comfortable position. The instrument most likely to prove useful in these cases is one recently constructed by me for a patient of Mr. Hilton's. It consisted of a pelvic band, vertebral lever, arm-pieces, and head stem; at the upper extremity of which were fixed two levers accurately curved to represent the shape of the head from its base to the temporal region. These levers held two arched plates resting upon the parietal bones; and at the point where they joined the head stem, a hinge and screw induced pressure

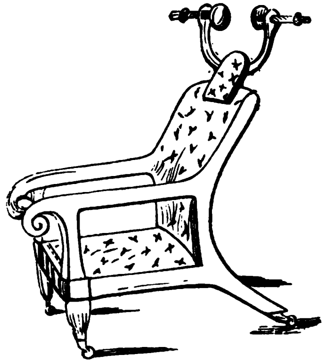
FIG. 37.



against the sides of the head at will. Immediately beneath this hinge a vertical rack, of very small dimensions, was fixed for the purpose of regulating the exact place where the parietal plates should rest. This apparatus is readily concealed beneath the hair, and holds the cervical vertebræ in a perfectly immovable position: hence it fulfils the same purpose as recumbency, with this additional advantage, that the patient can move about without producing injury to the spine.

For disease of the cervical vertebræ, a plan frequently adopted in Germany, is to place the patient in a semi-reclining posture, on an invalid chair, having a neck-piece so arranged

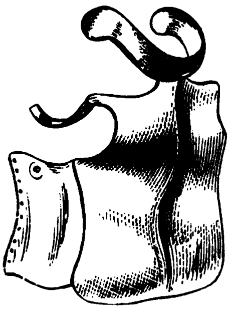
FIG. 38.



as to hold the head immovable, somewhat after the manner in which photographs are occasionally taken. Or two bags of sand placed on either side of the back of the head are adopted, instead of the photographic neck-piece.

Another piece of mechanism for holding the head and neck at rest, is simply a piece of gutta percha, accurately fitted to the back of the body and nape of the neck, with a slight metallic band, shaped to the occiput, fixed at its upper margin. The head rests in this without pain or trouble, and the patient, if young, for it is generally adopted in infantile cases, can be easily turned or moved without exciting the least apprehension of mischief being done to the diseased portion of the vertebræ. This arrange-

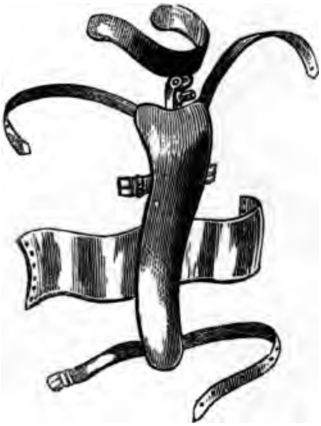
FIG. 39.



ment I have applied in cases under Mr. Birkett and Mr. Cooper Forster's care.

A very valuable appliance for angular curvature of the cervical region, resulting from caries, was suggested to me by Mr. Bishop for a case under his care. It is composed of

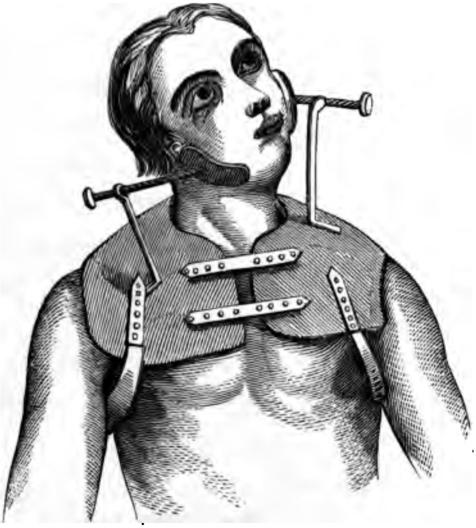
FIG. 40.



a light padded plate, accurately moulded to the form of the vertebræ, and having at its superior margin an occipital rest possessing free motion horizontally, free motion anteriorly, partial action posteriorly, and none at all laterally. When this is applied and firmly secured to the body by two shoulder-loops and a thoracic belt, the effect is to support the arc of spinal curvature, whilst the child freely moves its head in every direction but that likely to do harm.

Amongst some of the French appliances for wry-neck, is one formed as follows :—*

FIG. 41.



A collar of light metal rests upon the shoulders, having two metal rods with horizontal screws. These screws are attached to padded plates, which press against the inferior

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[*] This illustration is copied from Bonnet.

maxillary bone on the one side, and the malar bone on the other. Upon bringing the maxillary screw into action, rotation of the chin is secured, and by rendering the malar screw tight, vertical obliquity of the face results; both these actions being necessary for overcoming the retraction of the sterno-mastoid muscle.

The forms of apparatus devised for wry-neck and analogous cervical deformities, are extremely numerous; but those of which diagrams are given, serve to illustrate the kinds most in requisition at the present time.

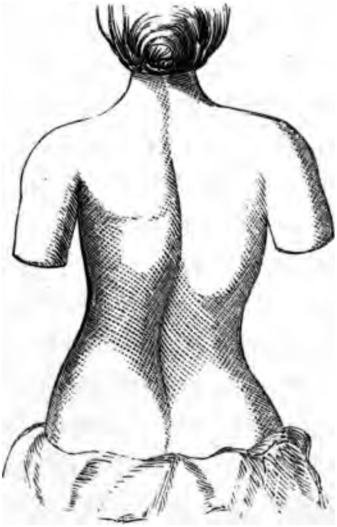
In one and all the true object to be mechanically accomplished, is that of first restoring the vertical line of the face, and then rotating the head in a direction adverse to that assumed by the deformity. Horizontal pressure against the chin fulfils the one part, force applied to the temporal region secures the other. When this is carefully accomplished, not only are the cervical curves sure to be diminished, but the muscular retraction becomes readily lengthened; which process may be greatly assisted by the section of the sterno-cleido-mastoideus.

CHAPTER VII.

DOUBLE LATERAL CURVATURE.

It is indisputable that there is more difference of opinion about the treatment of this, than of any other distortion of the human body. In spite of the labour spent in defining its anatomical character, and in suggesting the appliances best calculated for meeting its mechanical difficulties, little has as yet been effected towards a scientific demonstration of its curability. To attempt to enter into the physiological causes which originate spinal curvature would be to depart from the intention of the present work, which simply aims at affording an account, as clear and perspicuous as can possibly be given on so novel a subject, of the mechanical means available for ameliorating an undoubted double lateral curvature. To render this purpose intelligible, however, some explanation must be given of the leading anatomical features and mechanical difficulties. In this sense, double lateral curvature may be said to consist of a deflection of the spinal column in distinct and opposite directions. The spine is most frequently found to present two arcs of curvature, or deflection, from its true perpendicular line—one in the dorsal, or back, the other in the lumbar, or loin region.

FIG. 42.*



As I shall hereafter show that there may be three or even four curves in double lateral curvature, it might have been more correctly termed "compound lateral curvature." Where, however, only two deflections exist, they are familiarly known as the dorsal and lumbar curves. The dorsal presents itself as an arching sideways of the spine to so great an extent that the scapula, or shoulderblade, of one side is uplifted out of the position which it naturally occupies on a level with that of the opposite side; this is accompanied by a bulging backwards and outwards of the ribs, on the side of the body which corresponds with the highest point of the dorsal curve. The concavity formed by this deviation generally induces a flattening of the ribs on the opposite side, and a diminished condition of the muscular substances previously occupied in maintaining the spine in a normal position; for as it has frequently been stated that the spine forms a central column between two antagonistic systems of muscular chords of tension, either of which, if unduly exerted, leads it to assume a deflected condition, it necessarily follows that when a disturbance of equilibrium is produced by vertebral distortion, the muscles on the concave surfaces become attenuated and weakened, and thus enable their antagonists to retain the spine in a distorted shape until artificial mechanical agencies are employed to restore the disturbed balance.

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* This drawing has been made from a plaster of Paris cast; the figure is therefore taken from life, and serves to illustrate the usual form of double lateral curvature.

The lumbar curve is distinguished by a yielding of the vertebræ in a direction antagonistic to that of the dorsal—thus, if the former arches to the right side of the body, the latter would do so to the left, and *vice versâ*.

The lumbar curve leads to a considerable amount of thickening and enlargement of the loins, which is due to the fact that the sacrolumbalis and longissimus dorsi muscles become displaced, upraised from their normal situation. Besides these results, the hip, or ilium, of that side of the pelvis which is opposite to the upper (dorsal) curve, becomes enlarged in consequence of the changed condition of the lumbar and sacral vertebræ which thrust the ilium upwards, and frequently lead to the establishment of obliquity in the trochanteric, or hip, axes of the pelvis.

In addition to this mechanical arrangement for producing pure lateral movement in the vertebral bodies collectively, a peculiar function is fulfilled by a semi-elastic substance called the intervertebral cartilage, which is to be found between the individual bones.

Having explained thus far the ordinary appearance presented by lateral curvature, we will now enter more clearly into those conditions which produce it. Upon the resilience of the cartilaginous body more than upon anything else, depends that free and easy movement of the entire vertebræ which characterizes the possession of robust health. When either diseased action or inactivity of the whole body leads to diminished employment of the inherent elasticity of the intervertebral cartilages, an undue compression of their surfaces follows, and the malady called spinal curvature gains one of its proximate germs. Physiologically, the intervertebral cartilages may possess deficient nutrition in one or more elements of their component structures, in which case there is a lessening of their substance, and a disturbance of that just proportion which is required for maintaining the vertebral bones in their natural horizontal position. Or, as frequently happens, the earthy particles entering into the constituent elements of the body may be unequally distributed, in which case that part, or those parts, so affected yield to the superincumbent weight of the head and upper portion of the spine; rendered thus unstable in its centre either by softening of the bones or compression of the cartilaginous surfaces, destruction of equilibrium rapidly follows, and the spine, forced to maintain the head and upper extremities in their gravital relation to the remaining portions of the body, does so by the formation of a series of curves, consisting of two, three, or even four arcs; *but never of one*, such a mechanical condition being utterly impossible, unless induced by abstraction of the ribs, as occasionally, though rarely happens, where there has been caries and exfoliation of those bones.

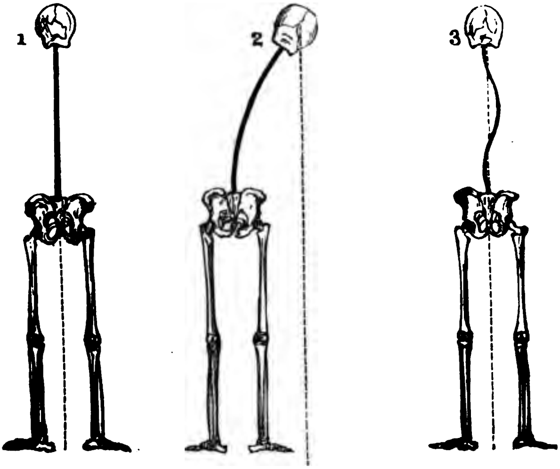
Although the experience of those professional readers, who from studying cases of spinal distortion have long since become acquainted with the rarity of a single curve, may appear to render my description a work of supererogation, yet as there are many who may peruse these pages without having previously acquired any knowledge of vertebral distortion, it is imperatively necessary that some scientific proof be given of the almost impossible existence of a single curve, except under the conditions of diseased action just stated.

To establish this statement and simplify the matter, let it be assumed that the head represents one extremity of an elastic column, and the pelvis, or hips, the other; likewise, that the central portion, or spine proper, can be moved freely in any given direction, with different degrees, however, of mechanical freedom or intensity. Let it also be admitted that the object of this elasticity is to maintain the head in a vertical position when the pelvis is perfectly horizontal. Granting these premises, it will be readily seen that if the head deviates from its central position, it can only do so at the expense of disturbing the maintenance of a true perpendicular line, and that on the side of such disturbance the head must eventually lean over, unless opposed and counteracted by some powerful retractile agency. Seeking, as we naturally should do, for the presence of this withholding power, it would at once be discovered that it resides in those muscular substances which are employed to maintain the head *en poise*, and especially those acting on the side opposite to that on which the head threatened its descent. Such muscular traction would, if the spine merely possessed one or two widely separated centres, be amply sufficient to sustain the yielding head and keep it within the area of gravity formed by that general base for the body—the legs. But as the spine consists of twenty-three distinct axes (for each bone may be considered as contributing a centre of movement), the mechanical force exerted to maintain the head from falling sideways, exercises such an influence over the various spinal centres as compels the establishment of another curve equal in extent and power to that of the one first established. This, in simple language, is the true explanation of the production of two or more arcs of curvature in the spine, as a sequence to primary disturbance of vertebral equilibrium.

The following diagrams show, firstly, the position assumed by the head in its relation to the pelvis; and secondly, the manner in which a compensating curve is created to balance the relative parts of the whole column correctly.

The first figure represents the head supported by the spine in a vertical position, and the force of gravity which enables it to be so sustained is delineated by a dotted mark passing from the top of the skull to a point between the feet.

FIG. 43.



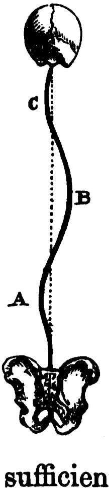
The second exhibits the head moved sufficiently to one side to throw the line of gravity beyond its base, as hitherto furnished by the feet, in which case it is needless to say, the human body would fall, in consequence of the abrogation of that mechanical law which declares that whenever the weight or gravital force of a body is transferred beyond the area of its base, such body can no longer retain a position of equilibrium or rest, but must yield in that direction to which the line of gravity subtends; and unless, by so doing, this line is brought within a base corresponding with the proportion of the declining body, it must inevitably fall, and thus obtain support from some other surface foreign to its own.

The third figure shows the restoration of the head to its previous place, as accomplished, not by the whole spine returning to its original position, but by its producing a second curve, by means of which the gravital centres of both arcs of curvature are brought within the base formed by the feet, and the head once more assumes its original position, at the expense of having created two opposing arcs of spinal curvature, each of which, by its own tendency to declination, seeks to counterpoise the head, when taking any other position than that of the central and vertical line of the body. If, however, skilful disturbance of this false equilibrium is engendered, then the spine gradually assumes a corrected and straight position, with the minimum of mechanical power, but the maximum of natural force.

Many careful surgical students of spinal distortions have held, that section of muscles or their tendons should tend to establish this peculiar restoration of the curved spinal column to its straight condition; but if they had reflected that division of the chords of tension contained within the concavities of an arc, or any series of arcs, can only mathematically lead to a closer approximation of their deflected extremities, by diminishing such resistance as nature affords to restorative action upon the whole column, they would surely have halted before promulgating so questionable a doctrine or system of treatment.

Believing, as I do, that nature possesses ample powers for restoring the spinal column to its perpendicular position, when the true key of the original deflection is solved by the discovery of the primary arc of curvature, the whole treatment of spinal distortion becomes a scientific, mathematical, and especially mechanical question. Although likely to run the risk of being accused of proving the same premises twice over, it is better to do so than let so important a view of spinal curvature remain misunderstood. Arguing in support of this hypothesis—viz., that the discovery of the primary arc is the true scientific road to treatment, let it be supposed that a triple curvature of the spine presents itself, in which the lumbar deflection has been the first established. It necessarily follows that upon redressing this by mechanical compression, such an amount of excessive deflection will be engendered in the areas of the other two, as to prevent the head and shoulders from being maintained in their first position. To prove this, let the lumbar curve, A, present its arc to the left side, the dorsal one, B, to the right, and the cervical curve, C, to the left, thus :—

FIG. 44.



Upon exercising sufficient mechanical power upon the high part of the lumbar curve to reduce it to a straight line, the head must of necessity be thrown considerably to the left side, thus destroying its balance. In the effort to restore the head to its vertical position, an unfolding or expansion of the dorsal arc would ensue, tending to divert the spine to the right side of the gravital line, which, in its turn, would compel the head to be again inclined to the left, and thus produce expansion of the cervical curve. But supposing, on the contrary, that in this case pressure had been first made upon the arc of the dorsal curve, an increase of the lumbar curve would result, and consequently a necessity engendered for the head to be inclined to the right side, and this would materially augment the upper curve, for as the head of the patient is maintained in its perpendicular position by a series of three curves, when it is deflected in the same direction as that of the upper or cervical curve, every effort made to restore the head to its original position serves but to approximate the extremities of the dorsal curve, which, as they become condensed or pressed towards each other, adds to the lumbar distortion, by necessitating, for a restoration of the centre of gravity, a still further flexing of the upper extremities to the right side, and by thus condensing the area of the lower or lumbar curvature, lead to an increase of the whole distortion. Thus it must be seen that unless the primary or proximate curve is discovered prior to any attempt being made to treat spinal curvature, all hope of a successful issue must prove empirical and futile, and only lead to useless expense and trouble.

The following axiom may therefore be established—"that if the primary curve is discovered and mechanically acted upon, all others, however numerous, redress themselves." This golden rule renders the treatment of spinal curvature one of strict mathematical certainty, and is probably the base of those successes, which are frequently found to crown analogous cases of spinal distortion when the same mechanical means are rigidly adopted, but which baffles the orthopædic practitioner by unaccountable failures when attempted in cases not amenable to the principle just enunciated.

It is quite possible to find the same instrument which produces cure of spinal distortions of one variety, utterly useless and frequently mischievous when applied to those that are similar only in external appearance, but not alike in mechanical origin. Hence anybody who advocates one especial form of apparatus for the treatment of every variety of spinal curvature, outrages common sense, sets scientific laws and investigations at defiance, and exposes those who trust to such recommendations to the ignominy of failure in practice, and the patient adopting it to the misfortune of increased deformity.

Nothing is more frequent in the experience of those who have carefully studied spinal curvature, than to obtain the most opposite results from the same system of mechanical treatment; a proof of the importance to be attached to the possession of mathematical and mechanical acquirements by those who essay either to devise instruments for curing spinal curvature, or seek to ameliorate cases by their agency. It must, therefore, be admitted that in arranging appliances for lateral curvature of the spine, much more knowledge is required than that imparted by a mere anatomical and physiological comprehension of the case. To these phases of intelligence must be superadded a full knowledge of the dynamic laws that regulate the production of curves, and their ultimate resolution into straight lines. In all other distortions of the human body, surgical acquirements alone may suffice to cure, with a moderate degree of certainty, whatever deviations from normal form may occur; but in those cases which owe their origin to vertebral disturbance surgical must be aided by mechanical information.

In the different forms of apparatuses by which this work is illustrated, the idea just enunciated must ever be held paramount, since it is to furnish the surgical world with mechanical assistance that these pages are compiled. In France, Germany, Austria, and Prussia, many efforts have been made to reduce the construction and arrangement of orthopractic appliances to a science; it remains now for England to follow so laudable an example, not by spasmodic efforts to prove certain plans of individual treatment superior to all others, but to chronicle, as a whole, the advantages resulting from a more general comprehension of those apparatuses which have been devised as if only needed for the use of the few, instead of the gain of the multitude. It is the duty of every man who professes to hold a scientific position to make his plans and proceedings well known to all who may profit by such teaching; no feeling of pecuniary loss should be allowed to prevent every form of instrument ever invented from becoming the property of all who choose to borrow the aid, which it is known to render. Often as it has been stated, that to publish a description of those inventions resulting from long study and great opportunities, must eventually lead to such diffusion as shall react against the interests of those who originally promulgate their value, it can never be a matter of pride or satisfaction to any one to feel that his inventive faculties are exercised solely for the sordid motive of personal emolument. It is far nobler to offer to the world all the knowledge and information on a special subject which one possesses, than to hoard its advantages, and be the only one to profit by its employment. There is also a certain reward secured to those who freely proffer their plans and designs, by the fame attached to them for the possession of ingenuity of thought and integrity of action.

Holding these views, I freely volunteer such knowledge and experience as I may possess, and place them at the disposal, not only of those who need their aid, but also of my own *confrères*, simply begging them to be guided by the same rule whenever opportunity offers.

There is one point that must not be overlooked, while naming the several advantages of a scientific treatment of deformities, which is, the support conferred upon those mechanists who devote their time to the construction of mechanical appliances, by the assistance and encouragement given by the leading members of the medical profession.

There cannot either be the least doubt that much valuable information, and many practical suggestions, are constantly promulgated by the Orthopædic School of Surgery, yet it must also be remembered with regret, that with but one or two honourable exceptions, the plans of treatment pursued in private practice are frequently rigidly kept within the arena of the individual's circle of patients. It is, however, utterly impossible, in these intelligent days, when knowledge is widely diffused amongst all classes of society, to permanently keep secret matters of public interest; and if this truism applies to ordinary subjects, how much more directly so to those which affect the health and shapely development of that large section of the general community, which has the misfortune to be afflicted by God beyond its fellows.

The spread of that branch of science which has led to the formation of a deductive system of mechanical treatment in cases of deformity, is mainly due to the enlightened spirit distinctive of those leading members of the surgical and medical profession, who have availed themselves of every opportunity, public or private, of practically testing the different mechanical inventions devised for the restoration or amelioration of distortions. Numberless examples might easily be quoted where our principal surgeons, after dividing tendons, have superintended the construction of mechanical appliances, looked to the *modus operandi*, and eventually restored their patients to pristine strength, form, and beauty. It thus follows, that a new system of treatment having been inaugurated by the few, its usages and plans have become the property of the many; and that whoever contributes towards the alteration of faulty details, fulfils the purpose for which all scientific efforts are rightly made, *i.e.* he places his stone on the grand corner of truth and knowledge.

In seeking to, soundly and practically, carry out a full exposition of the appliances invented for the restoration of spinal curvature, it becomes necessary to describe, tersely but comprehensively, their leading characteristics. It will, therefore, be found that the description of each apparatus is accompanied by just such an explanation of the surgical conditions which it is expected to fulfil, as may serve to render the mechanical action intelligible. Thus, when treating of the inefficiency of certain well-known spinal apparatuses, their weak and unscientific character is established by the aid of any diagrams that tend to show the surgical as well as mechanical errors promulgated by the individuals who advocate their use. On the other hand, such appliances as have been adopted by Sir B. Brodie, Mr. Fergusson, Mr. Hilton, Mr. Erichsen, Mr. Solly, Mr. Tatum, Mr. H. C. Johnson, Mr. Paget, Mr. Holt, &c., are described, with the anatomical advantages belonging to their construction.

CHAPTER VIII.

THE PRINCIPLES WHICH GOVERN THE APPLICATION OF MECHANICAL APPARATUSES TO DOUBLE LATERAL CURVATURE; WITH A DESCRIPTION OF A NEW FORM OF SPINAL INSTRUMENT FOR SECURING AMELIORATION AND EVENTUAL CURE.*

BEFORE proceeding to classify and describe such appliances as are especially constructed for the reduction of double lateral curvature, it is perhaps expedient for me to place before the reader those mechanical conditions which every form of apparatus must fulfil which aims at restoring the spine to a normal position. In order that I may do this efficiently, and render the subject clear and intelligible, four drawings are given, in all of which the same identical form of curvature is preserved.

The first represents an external view of the body when subjected to lateral distortion; and it will be perceived that the spine presents two distinct curves, the arc of the upper or dorsal deflection exhibiting itself towards the right side, whilst the arc of the lower or lumbar is seen bulging on the left. This condition is maintained throughout the whole four diagrams, to give me an opportunity of proving the correctness of the principles which I am about to enunciate. It is also the form of deviation most commonly met with in cases of lateral curvature.

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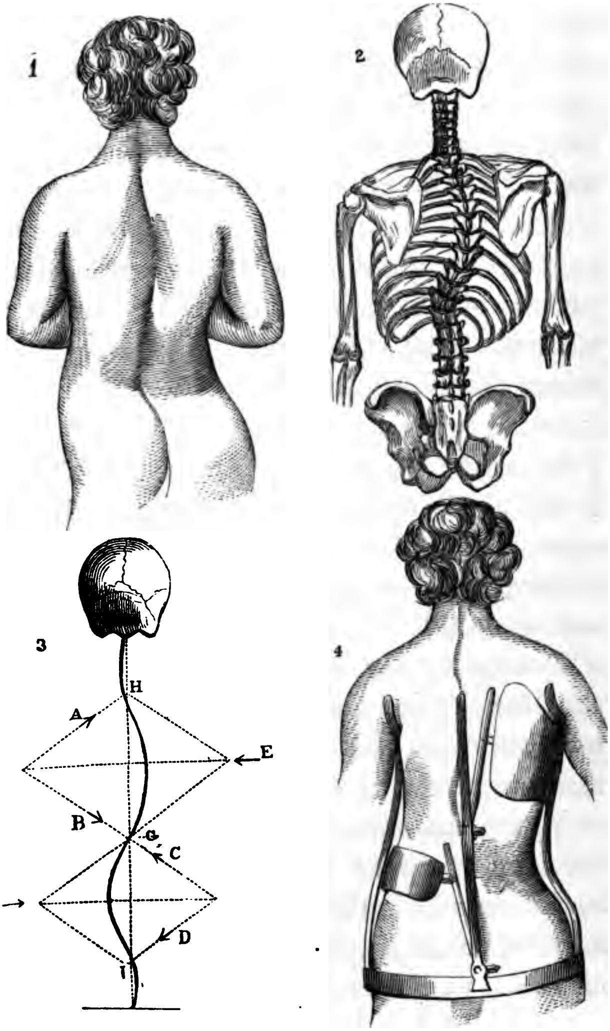
* I have to thank Mr. Brodhurst for the suggestions which led to the invention of this instrument. His scientific attainments must guarantee its value to the profession.

In the second drawing, the osseous structure of the vertebræ is seen as it actually exists in these cases, the bodies of the vertebræ being oblique, and the margins of the ribs unduly approximated.

In Fig. 3, an attempt is made to prove, by a mathematical diagram, the exact direction which should be taken by any mechanical apparatus seeking to diminish the deformity.

And, in the 4th Figure, an instrument is shown, adjusted to the body in such a manner as to accurately embody the scientific principles declared to be necessary for successful treatment.

FIG. 45.

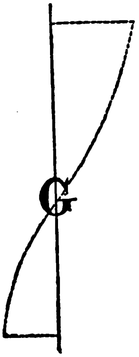


I shall now proceed to give my reasons for especially introducing a particular form of instrument prior to describing those more ordinarily adopted; but, before doing so, must impress upon the reader's mind that the salient points of the case before him are a bending of the upper portion of the spine towards the right side, with a compensating yielding of the spine, at its lowest portion, to the left. When these features present themselves, the right shoulder is found to be uplifted, in consequence of its forming the high point of the upper curve; whilst the left side is enlarged, through an analogous though opposite cause. The left arm is also seen to be within the concavity of the dorsal curve, and thus falls lower than the right, adding still more to the enlargement of the right shoulder. The reason why the left shoulder becomes lower than the right, is because the margins of the ribs within the dorsal concavity are approximated, by which the distance is lessened between the extreme points of the surface to which the arm in question and its muscles are attached. In further explanation of these particular characteristics of lateral curvature, it must be remembered that, whenever such a cylindrical column as the spine is arched laterally, its extremities are of course approximated. Thus, as the left shoulder is shown to form the upper extremity of the dorsal concavity, it descends in the ratio of its approximation to its mathematical complement: a state of things which causes the ribs and shoulder of the right side, which represent the highest part of the dorsal convexity, to become proportionately prominent.

These points being remembered, I would again draw attention to the first figure, where it will be seen that the right shoulder and left hip are bulged, whilst the left ribs and right side are depressed. To ascertain the anatomical reason for this arrangement, the second drawing must be examined; and it will be at once evident that it arises from the bodies of the vertebræ having changed their true horizontal axes, and become permanently fixed as component elements of two antagonistic curves, corresponding in position with the high and depressed surfaces depicted in the first figure.

These osseous curves possess two convexities and two concavities, bearing established ratios to each other, and meeting at a common point, which may be represented by G in the accompanying diagram. This point corresponds with the termination of the dorsal and the commencement of the lumbar curve in Fig. 3, and is on the mesial line of the body.

FIG. 46.



In the third illustration, both the curves already described are found to possess a common chord, H, G, and I. It is, therefore, at once apparent that the only scientific method by which these curves can be made to assume a straight line, is the employment of equal but opposite lateral power against the arcs of both. E F represent the direction of these required forces, which, when brought into operation, immediately meet with resistance at H G and G I, these being the extremities of each curve. For, upon any power being applied at the arc E, resistance must occur at H G, its extremities; but, as resistance at the extremities of an arc may always be resolved into two distinct forces, A B would represent the direction of the ensuing counter-resistance. Thus again, by the same rule, if power be exercised at F, counter-resistance is to be set up at G I, in the direction C D. This being indisputable, we next find that the concavity of the other curve, H E G, is embraced by the sides of a parallelogram, A B; whilst the concavity of the arc G F I, is included in the parallelogram C D. E and F form the diagonals of both these parallelograms, and therefore represent the direction of the forces requisite for the due unfolding of both curves.

But it will also be perceived that the line B, the lower side of the parallelogram, A, B, H, G, and the line C, the upper side of the parallelogram, C, D, F, G, are coincident—the direction of their forces being equal and opposite—and that they thus negative each other and make their common centre G a fixed point, which fixed point is also the precise spot at which both the dorsal and lumbar curves join. G is therefore found to be on the mesial line of the body, and vertical to the other fixed point I, as is indicated by the dotted line H, G, I, mesially uniting the base of the skull with the centre of the pelvis.

For practical purposes it may therefore be concluded that to reduce a case of double lateral curvature of the spine to normal position, force must invariably be used upon the apices of its arcs in the direction indicated by the lines E, F, and that this force must originate from the two centres G and I.

From this illustration of the mechanical principles involved in all cases of lateral spinal curvature, it follows that the apparatus selected for the treatment of the malady should be so constructed as to fulfil the conditions which are clearly essential under the unvarying laws here set forth. If, therefore, in seeking to devise this, the question were asked, in what manner should force be so applied as to exercise pressure on the arcs of curvature with the greatest economy of time, material, and power, the inquiry would be answered by the self-evident statement, that any instrument having a firm pelvic base, and acting upon the dorsal and lumbar prominences in the same direction as E and F, would best secure the end sought.

It would likewise be clear that the power brought to bear upon the arcs of curvature must coincide, as to their centres of movement, with the fixed point in the spine, G, and the fixed pelvic point, I.

It consequently follows, apart from any specific description of the instrument which accomplishes this, that it must have two centres of movement agreeing with G I of the mathematical diagram, and two surfaces of resistance corresponding with E F.

To give this actual form, reference must be made to the fourth diagram, where an instrument is figured which has two ratchet centres of movement coinciding with (G) the common centre of the two curves and (I) the pelvic centre. There are also two padded metal plates resting upon the dorsal, E, and the lumbar, F, arcs of deflection, their force being employed in directions coincident with these lines. A provision is also made for elongating the extremities of each curve, and uplifting the depressed shoulder by means of lateral crutches, fixed to a firm but well-padded pelvic band.

Representing the natural position of the spine, there is also a vertebral metallic lever which affords points of fixation for the ratchet stems which govern the action of the two plates. The whole is held firmly in position by the padded pelvic band already mentioned, to which both the lateral crutches and the back stem are attached.

To show the high importance of an accurate knowledge of anatomy and mechanics in the adaptation of spinal apparatuses, it is sufficient to say, that had the ratchet centres been established at any other point in the vertebral stem than those just defined, the whole scientific theory would become a nullity, and the curve requiring treatment fail for want of proper scientific comprehension of the laws of vertebral curvature.

Many apparatuses are to be found in the following pages, which depend for their mechanical merit on the compression of both arcs of curvature, but they have been invariably suggested by practitioners who failed to see that the true centres of movements could only be at certain points, admitting, as I have shown, of no variety or dispute.

I have applied many thousands of spinal instruments, but never found any which met every mechanical exigency, and resolved double lateral curvature with greater mathematical accuracy than the appliance just treated on. It is impossible to over-estimate the advantage of a really good and clever spinal apparatus, as it enables those who apply it to economize time, diminish discomfort, and eventually secure every advantage which the conditions of the case admit of.

Having thus given a very brief although elaborate description of the conditions demanded for the successful treatment of spinal curvature, the reader will be enabled to judge for himself as to the relative advantages possessed by those instruments which are mentioned further on.

As a matter of convenience, I have divided them into four distinct groups, based upon the different methods of mechanical treatment at present adopted by the leading members of the profession. The reader will thus be enabled to gain a knowledge of every popular spinal appliance yet introduced into practice.

CHAPTER IX.

APPLIANCES INTENDED TO ACT UPON THE SPINE THROUGH THE MEDIUM OF RECUMBENCY, WITH A DESCRIPTION OF VARIOUS ORTHOPÆDIC, ORTHORACHIDIC, PRONE, AND INCLINED COUCHES.

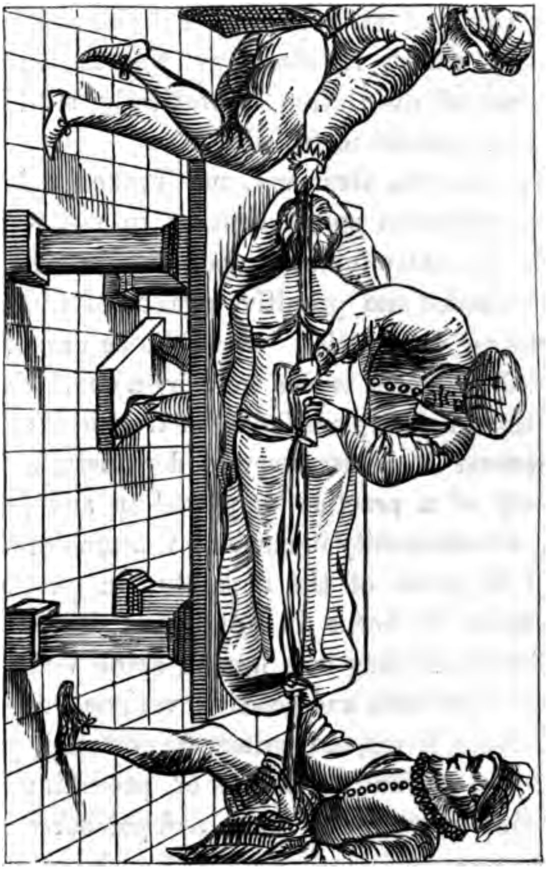
GROUP I.

I PURPOSE dividing the various apparatuses for the treatment of lateral spinal curvature into four separate and distinct heads. And in the first division I place all those appliances which are intended to act upon the spine by the removal of vertical pressure, by means of a prone or recumbent position. It is, perhaps, right to state that all forms of reclining surfaces on which the patient is placed face downwards are known as prone, while those in which the patient lies upon the back are called recumbent couches. The earliest known modern adoption of the recumbent posture for the curative treatment of scoliosis, is recorded of a case in which Dr. Darwin is mentioned as having introduced the system of reclination for the amelioration of spinal curves. A description, however, is given in Ambrose Paré's work, of a couch devised for the purpose of remedying spinal curvature; but whether it was simply used as a kind of operating table, or, as is less probable, for a permanent resting-place, is not clearly shown. As it is, perhaps, the earliest couch on record, we will give a description of its form and uses.

The patient was laid in a prone position, having a band placed under his arms, and another around his hips. Assistants were then employed to drag the crooked spine into a straight condition; this process being aided by strong pressure being made upon the ribs by the hands and knees of a third assistant. Sometimes plates of metal were employed to compress the ribs instead of the human agents.

It is scarcely possible to suppose that so barbarous a method of practice ever had more than occasional adoption, founded as it was on the supposition that deformed spine depended upon a state of semi-luxation or dislocation of the bodies of the vertebræ, and that to restore them to their natural position

Fig. 47.



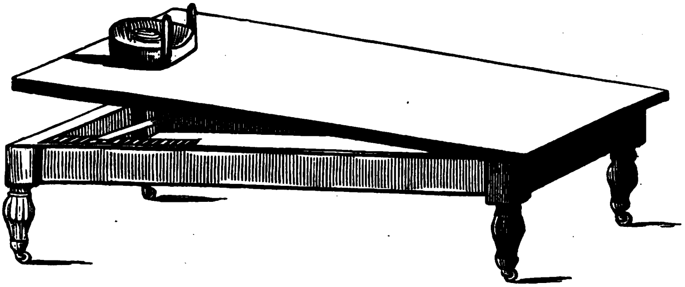
demanded quite as much force as would be expended in replacing a dislocated head of the femur into the acetabulum. The idea of extension and lateral compression, however, has survived even to this enlightened age, which, whilst it abandons the notion of "vertebral dislocation," practically stultifies its new professions of faith.

In Austria, Germany, and France I have frequently seen spinal couches in use, which were evidently founded upon Ambrose Paré's oft ridiculed and primitive method of treating vertebral deformities. It would be useless to crowd the pages of this work by a chronicle of all these half-exploded plans of treatment; but whenever it is necessary to demonstrate the falsity of a practice employed in any large city or community in our own times, a drawing will be given of the apparatus in question. It must be borne in mind that instead of assistants to drag the human spine violently into better form and position, various weights, bandages, levers, and springs are now employed; yet the leading principle of producing extension between the skull and pelvis remains the same.

As Ambrose Paré considered spinal curvature to depend upon a semi-luxation of the various bodies of the vertebræ, he was, to a certain extent, justified in recommending his apparatus; but, as modern surgery has accurately determined the nature and character of scoliosis, it becomes apparent that a great amount of mischief must follow if his supposition be still practically acted upon.

After Dr. Darwin had promulgated his theory on the value of recumbency, it was adopted by Dr. Harrison, whose name the system still bears. Dr. Harrison used to place the patient in a prone position, on an inclined couch, and then press and knead the ribs and vertebral bodies with the hands, until a certain amount of suppleness was produced. The patient was then laid on her back, and the surface on which she reposed being raised to an angle of about 25°, whilst the head was held in a fixed position in a padded receptacle like a horse's collar, the whole weight of the lower extremities was permitted to exercise its gravital force in procuring an elongation of the spinal curves by traction. It is needless to say that even granting that such a monstrous piece of absurdity as this was justified by some slight hope of rendering the spinal column lax and yielding, it must have led to a diminution of power in the muscular substances supporting the vertebræ; hence, when the patient so treated attempted, after probably five or six years of kneading and reclination, to stand erect, that inherent force given to the body by nature for upholding the spine in its erect position, would have been so greatly deteriorated, if not entirely wanting, that a rapid retrogression towards the original deformity must inevitably have ensued. The following gives a rough sketch of the inclined plane adopted by Dr. Harrison :—

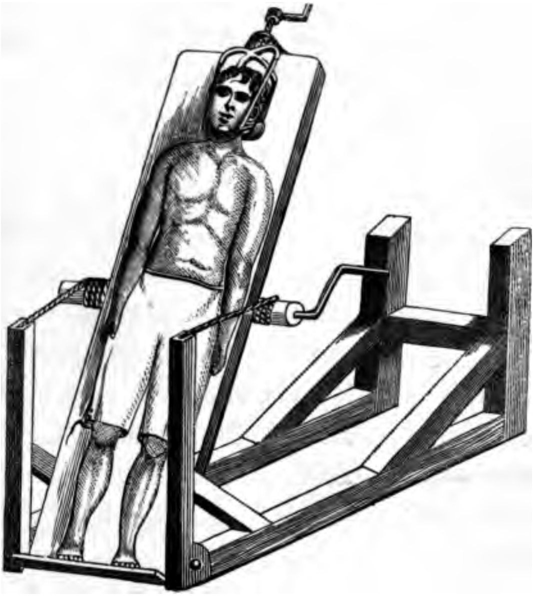
FIG. 48.



He also occasionally applied metallic pads to the ribs (analogous to Ambrose Paré's teaching) to aid the extension of vertebral curves induced by the inclined plane.

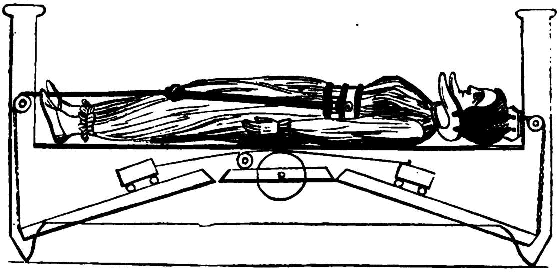
Another apparatus, based on similar reasoning, was devised by Mr. Sheldrake, who, however, seems to have entertained a far more philosophic estimate of the value of recumbency, since he only advises, in his writings, that the couch should be used at night, whilst a portable apparatus fulfilled its function by day. His machine consisted of a frame, so constructed that the surface on which the patient eventually reclined, could, by means of a winch and pulley, assume a vertical position. Whilst in this state, the patient's head was secured to the apparatus by a strap passing under the base of the skull, and another beneath the chin. These two straps were next secured to an arched piece of metal fixed to the upper margin of the reclining surface, and this curved piece of metal was then wound up until the patient's neck and spine were stretched to such an extent as to place the body on tip-toes. When this point was gained, the inclined surface became lowered, carrying the patient with it, until an angle of 25° was attained, when the patient was left for the night. In the morning the inclined plane was again wound up till it assumed its erect position, then the patient was let down from the neck crane, and an instrument (described at page 91) fixed to the trunk.

FIG. 49.



A more modern form of instrument, based, however, on the same principles, is even now adopted in France. It consists of a couch on which the patient is laid whilst his hips and head are held by padded bandages fixed to pulleys. These pulleys are acted upon by weights, placed in such a manner as to secure extension between the head and the pelvis.

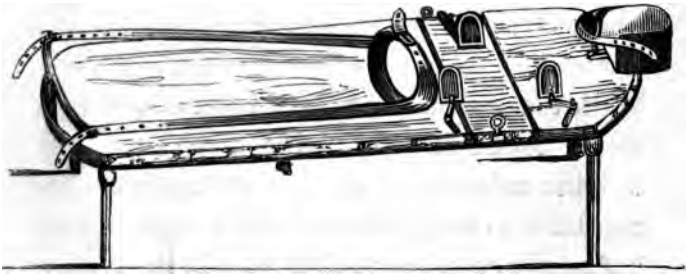
FIG. 50.



With that amount of refined ingenuity always to be found in our Gallic neighbours, the weights are so arranged that extension can be regulated to the greatest nicety and precision; but, as the principle itself is false in its relation to mechanical science, we may regard it as a pretty professional plaything, more than an actual agent for the restoration of spinal curvature.

In Germany a still higher degree of mechanical ingenuity has been exercised in rendering the reclining system available as a means for treating lateral curvature. Not contenting themselves with simple elongation of the spine, the Germans also establish lateral pressure against the ribs. These two forces act synchronously, that is, at the same moment. The following diagram gives a description of an apparatus procured by me whilst at Vienna only four years ago; it may therefore be accepted as offering an illustration of the present system of treatment.

FIG. 51.



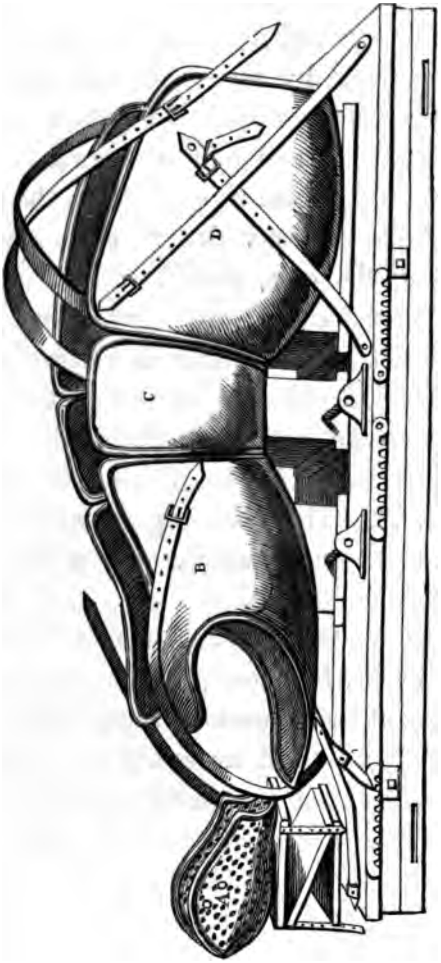
The couch is divided into three parts, the upper corresponding with the cervical, the middle with the dorsal, and the lower with the lumbar curves. The head of the patient is firmly secured by straps to a padded receptacle; the hips are also surrounded by a padded belt, which is fastened by lateral straps to a powerful spring fixed at the end of the couch. Two padded plates, moving by screws in three directions—forwards, upwards, and sideways—are fixed to the margins of the plane; one being attached to the edge corresponding with the dorsal curve, and the other at the edge coinciding with the lumbar arc of deflection. Upon screwing these plates, pressure upon the lumbar region and the dorsal ribs at once occurs in opposite directions: that is to say, the dorsal-plate presses the ribs from right to left, whilst the lumbar-plate acts from left to right, hence the two curves are simultaneously unfolded. At that portion of the inclined surface or plane where its first division takes place, a screw centre is so arranged that upon moving it the two portions separate, as shown in the engraving. There is also a screw centre arranged for the lower division of the couch; but on the margin opposite to the first. The effect of these screw centres is to, hinge-like, open the surface on which the patient reposes, on opposite sides, and as he has been previously fixed by the action of the plates and straps against the ribs, head, and pelvis, the body is distorted in a direction *antagonistic* to that of the deformity.

It is, in fact, carrying out the principle of unfolding curves by pressure upon their apices and expansion of their extremities. The plan is admirable, and calculated, better than any other form of recumbent apparatus, to fulfil the intended object. There remains, however, the almost insurmountable difficulty of compelling the patient to assume this position for a sufficient period; for unless the traction of the apparatus is constantly maintained its value becomes diminished. To those professional men, however, who do not mind having their patients placed in a recumbent posture for two or three years, this appliance offers a readier method of cure than, probably, any yet devised. It requires, however, to be constructed by an extremely able mechanician, as each centre must correspond precisely with those established by nature in the formation of the original deformity. This assistance can nevertheless be secured by applying in proper quarters.

The next form of apparatus is one on somewhat similar principles, which is used in Paris, its inventor being an ingenious mechanician named Valerius. It is called a "corset-lit," and, as its name implies, forms a bed or couch, in which the patient is placed recumbent. The apparatus is divided into three sections, moving, by screws, in opposite horizontal directions; whilst elongation is also obtainable at the will of the operator. The head rests on a padded receptacle, A, the position of which can be varied so as to suit the condition of the case, should cervical curvature be complicated with dorsal and lumbar deflections. The thorax is received by a padded shield, B; the lumbar region rests on a similar moveable surface, C; whilst the pelvis is firmly embraced by the lower part of the apparatus, D. The following drawing of its form will at once explain the advantages resulting from its use.

Another modern French couch has been invented by M. Moncour; but, as it is simply a repetition of the extension principle described at page 177, it is not necessary to repeat it. Extension between the pelvis and the upper portion of the thorax is its leading principle, which, as it slightly differs from the one first mentioned, inasmuch as that selected the base of the cranium, whilst this embraces the

FIG. 52.

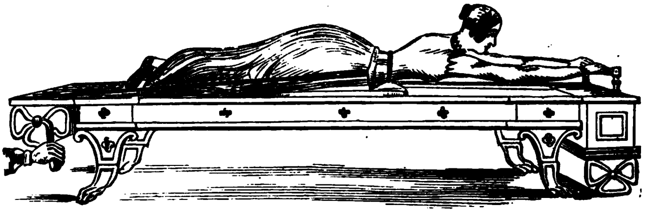


For inclination, compression, and extension.

dorsal ribs, has given it a title to be inserted amongst other modern appliances.

Another form of couch for the treatment of these maladies is as follows, and known as "Coles' Orthopædic Sofa."

FIG. 53.



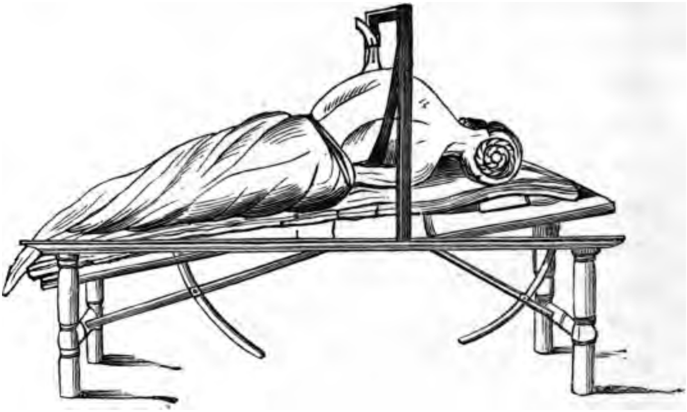
It consists of a padded sofa on which the patient is placed in a prone posture. A soft belt surrounds the hips, and terminates by lateral straps in a winch turned by the hand of an attendant. The hands of the patient grasp firmly a rod placed at arm's-length, and extension of the spine, by means of the winch, takes place. This is a very ingenious piece of mechanism for the purpose it is intended to effect.

Another form of bed or couch is that used by the late Mr. Lonsdale, the scientific nature of which is, however, of a very questionable character, for, as will be seen from the delineation given by the author, the sustaining surface is only applied to the dorsal arc of curvature, and tends materially to increase that curve of compensation which is invariably to be found in the lumbar region. Mr. Lonsdale fell, as his followers of the present time do, into the error of supposing that only one curve ordinarily existed, and to such an extent was this fallacy carried, that, in all the diagrams given in the sensible little book published by him on the treatment of spinal curvature, the presence of a lumbar curve is, with one exception, entirely ignored. It will be at once evident to the understanding of any one who examines the following diagram, which is taken from his own book, that the lower curve could but be increased by any force brought to bear on the dorsal ribs. The apparatus may be thus briefly described:—

It consists of a couch made on the same principle as Earl's triple inclined plane, having at its centre two wooden standards, giving attachment to a broad webbing band, which passes across the arc of dorsal curvature.

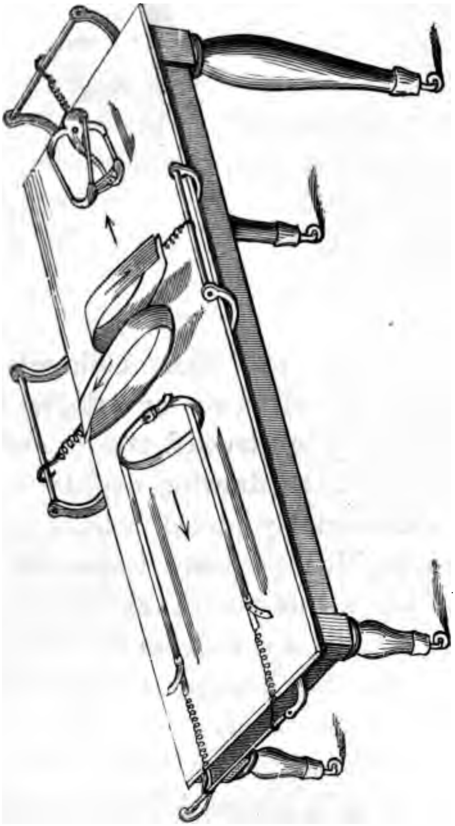
The patient is supposed to recline constantly on the side; but this position involves another evil of considerable magnitude, namely, a predisposition to rotate the ribs around their vertebral axes, and thus obliterate those natural curves which are an integral part of every properly constructed thorax and spine. For, although the drawing depicts the right arm as comfortably placed beneath the ribs, it is a position perfectly impossible to be maintained without such discomfort as no patient would long endure: hence the right arm is eventually brought forward and rotation of the ribs created.

FIG. 54.



Where reclination is considered advisable, the following couch, invented by me many years since, embraces all the conditions of known value, and may confidently be adopted. It produces extension of the spine, with lateral pressure against the ribs, established, too, in such a

FIG. 55.



manner as affords comfort to the patient, whilst at the same time it effects a high scientific purpose.

The mechanical traction is made by india-rubber, so that the body can move freely in any direction, and yet remain subject to the corrective force applied in extending the spine and compressing the curvature.

It consists, as may be seen from the above illustration, of a well-padded surface, with a rest for the head, to be moved obliquely upwards by means of an elastic cord fixed to the upper rail of the plane.

At the lower edge of the plane, another rail is arranged for the attachment of two elastic bands belonging to a padded belt, which is fastened round the hips. Another rail is arranged at the side corresponding with the dorsal curve, and a fourth rail is fixed at the lateral edge of the plane answering to the lumbar curve. To both these rails soft webbing bands are fastened, which carry elastic cords, and these webbing bands pass in antagonistic directions over the arcs of dorsal and lumbar deflections.

The great and important advantages attached to this invention are, that the body can move in any direction. The only restraint exercised being by the elastic cords, which, although allowing perfect freedom of motion, are constantly retractile in a direction opposed to the condition of the curve. Thus the head can move freely in all directions, yet when passive, is drawn upwards from the body, hence lessening any cervical curve that may exist.

The trunk can also move freely to either side; but when quiescent a constant traction is exerted against the arcs of both dorsal and lumbar curves, which tends to lessen their lateral increase. The legs and pelvis can also move at will; but a considerable amount of extension is applied to the pelvis by the elastic cords at the foot rail: thus elongation of the lumbar and dorsal curves is ensured. It fulfils, in a word, every requisition aimed at by the more costly forms of apparatus; and when combined, as it can be, with means for exercising the arms, furnishes the most admirable couch ever constructed for the treatment of lateral curvature.

This apparatus will conclude the description of those appliances included in the first division of our proposed classification. I have taken great pains to ascertain whether any others worthy of notice existed; but finding none that differed in any material sense, I hold that the number is completed.

CHAPTER X.

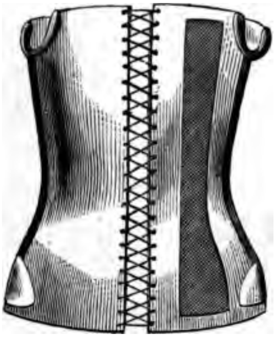
INSTRUMENTS TO REMOVE THE WEIGHT OF THE HEAD AND SHOULDERS FROM THE SPINE, AND PLACE IT ON THE PELVIS.

GROUP II.

The second group of apparatuses embraces all those intended to remove the weight of the head and shoulders from the spine, by transferring it to the pelvis. It may be fairly held an established law, that, next in order to the system of reclination or entire relief to the spinal column by means of bodily rest, the plan of transferring whatever weight acts inimically against the spine to that portion of the body which, from its unyielding character, offers less chance of mischief, has been almost universally adopted. No sooner did the evils resulting from continued recumbency, as practised under the systems of Darwin and Harrison, become clearly palpable to the profession and public, than agencies were sought which might enable the patient to take ordinary exercise, and yet find relief from the superincumbent weight of the head and shoulders. For, as the spinal column is less capable of sustaining the natural weight of the head, in proportion to the transverse area of the abnormal vertebral curves; so whatever is calculated to support the arms, and thus considerably diminish the gravital force of the whole superior mass, is undoubtedly advantageous, and gives, although in a comparatively imperfect manner, mechanical aid of no slight value.

The first form of support based upon this idea was an ordinary stiffened stay, the whalebone sides of which receive and support the thorax, conveying a considerable portion of its weight to the pelvis, on which the stays rest. As, however, stays simply thickened with whalebone readily change their shape laterally, when subjected to long-continued bodily warmth, more harm than good constantly resulted whenever the form of the stay became coincident with the concavities of the different lateral spinal curves. Under these circumstances, the stay simply confirmed and maintained the deformity, without in the least degree ameliorating it. The self-evident improvement upon this plan, therefore, was the introduction of lateral metal crutches, so arranged that the arms rested firmly on the upper surface, while the hips were embraced by their inferior terminations. A sketch of this form of support is appended. In addition to the mere fact that lateral uprights were attached to the stay, was that of their being made to elongate, and thus enable the crutch next to the concavity of the dorsal arc to be raised higher than its fellow on the opposite side. Besides the lateral uprights, a padded plate of thin metal was frequently introduced,

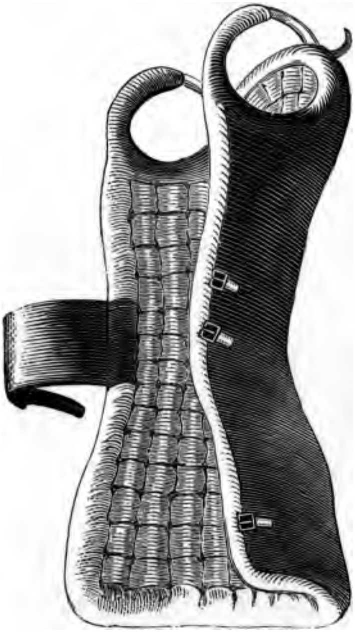
FIG. 56.



for the sake of adding strength to the retaining surfaces.

As stays required a great deal of care in making them fit the body properly, and were rarely even then productive of such support as some cases of great muscular debility demanded, a padded metal shield was strongly advocated by French surgeons; the form of

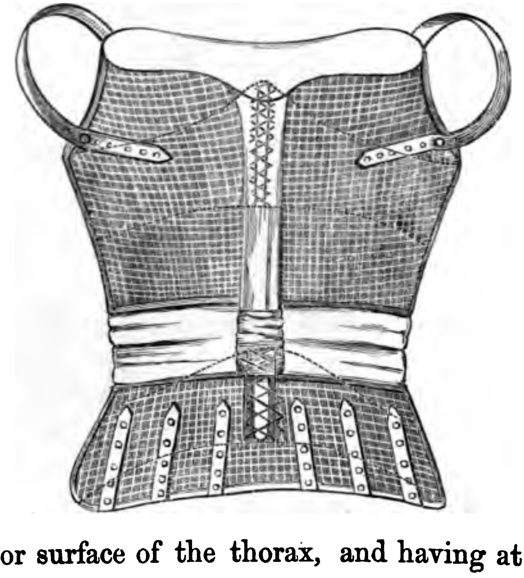
Fig. 57.



support, and its arrangement being as shown on the preceding page.

Another form of apparatus of great value where vertebral weakness has to be overcome, was invented by Dr. Abbe of Boston, U.S., for which I possess a patent in England. It is termed the Orthospinalis, from the wedding of a Greek with a Latin word, signifying to straighten the spine. It consists of a light metallic frame, accurately representing the posterior surface of the thorax, and having at its

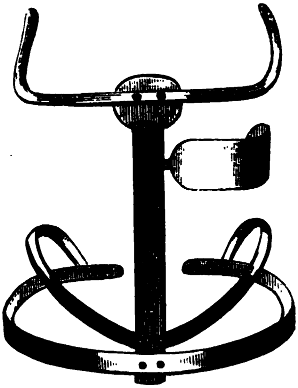
Fig. 58.



centre, coincident with that point where the lumbar and dorsal curves generally blend, a free joint, separating the apparatus into two distinct sections, held together by the joint just mentioned. On either side of the central joints bands of india-rubber are fixed, which by their reaction against each other, serve to keep the apparatus in a strong, though elastic perpendicular condition. This instrument takes its principal bearing around the pelvis, and as its whole shape resembles that of a perfectly formed body, all trace of curvature is hidden, and in lieu a perfectly symmetrical form becomes presented. It is an extremely clever invention; and for supporting a weakened spine or preventing lateral curvature, better than anything else I am acquainted with.

Another instrument very extensively used, is that invented by my father and adopted by Sir Astley Cooper, who used it for all his spinal patients. It has furnished the basis for a large number of apparatuses which will be found described in these pages, and, with slight modifications, been made to serve the name and purpose of almost all the practitioners who first began to make the treatment of deformities their speciality.

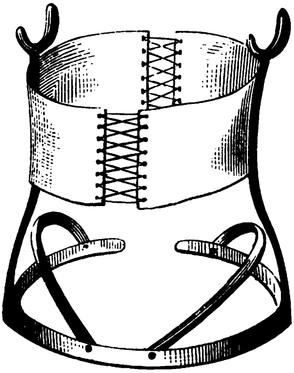
FIG. 59.



It is formed of a pelvic band which encircles the hips, and rests on the superior spinous process of the ilia by means of two arcs of metal. The arms receive support from two horizontal levers, separated at their centres, and capable of being raised or lowered at pleasure. These arm-pieces are joined to the hip-band by a vertical stem softly padded, and forming an artificial spine. To the lateral margin of this back stem a plate which rests against the prominent ribs is attached, and being formed on the principle of a spring, maintains constant rotative action against the ribs; which proves that it was the first instrument in which this peculiar condition of rotation of the ribs on the bodies of the vertebræ was foreseen and guarded against; for although some modern writers mention horizontal costal rotation as a recent anatomical discovery, its existence has been known for at least fifty years, and the disturbance engendered by its presence mechanically encountered and overcome.

Another form of appliance for removing the weight of the arms and placing it on the pelvis may be described as follows:

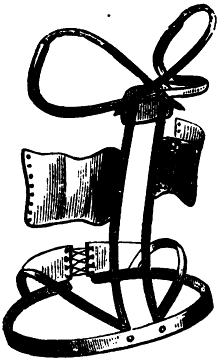
FIG. 60



The all but universal pelvic-band is here made the base of support for two lateral uprights, which support the spine and yet leave its spinous processes perfectly free and untouched, except by a soft lacing-band connecting the uprights transversely together. Where spinal irritation exists,* this kind of appliance is the best that can be used, for the obvious reason that it leaves the spine free from even accidental pressure.

When the vertebræ exhibit any condition of tenderness, either from being thinly covered with integument or irritation of the medullary sheath, the spinal support is frequently constructed in this form, which possesses the ad-

Fig. 61.



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* Where the spine requires more than usual support, the lateral uprights are prolonged at their lowest margin, so as to rest against the seat of the chair when the patient is in a sitting posture.

vantage of being more easily concealed by the dress than the one just described.

The only difference between it and Fig. 59 is in the circumstance that the posterior vertebral stem is divided into two parts, so that the spine, whilst supported, remains untouched.

These appliances, which have been described as briefly as possible, represent all the most important forms of apparatus for removing the superincumbent weight of the head and shoulders, and placing it upon the pelvis: it may, however, be stated, that those instruments described under the head of cervical curvature, are occasionally used for this purpose when the weight of the head *per se* is a subject for consideration; it would, however, only be multiplying descriptions unnecessarily to include them here.

CHAPTER XI.

APPARATUS INTENDED TO ACT UPON THE CURVES BY LATERAL PRESSURE, EMBRACING EVERY POPULAR INSTRUMENT ADOPTED DURING THE LAST FIFTY YEARS, FROM THE SIMPLEST STAY TO THE MOST COMPLICATE MECHANISM.

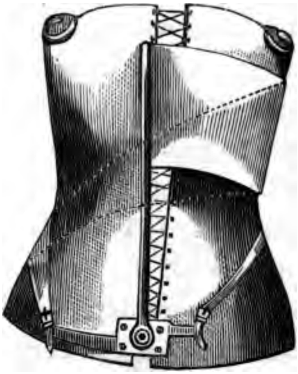
GROUP III.

In the third group of instruments for the treatment of double-lateral curvature are those which not only remove the weight of the head and shoulders, but also tend, by acting against the antagonistic dorsal and lumbar arcs, to depress their highest points, expand their extremities and restore the vertebræ to a normal line, by gradually obliterating the areas embraced by the opposing lateral concavities.

The apparatuses belonging to this division are deservedly held to be more important than any others, owing to the circumstance that they include almost every form of spinal instrument that has gained popular favour—either through the exertions of their inventors, or the ingenuity of their peculiar construction. Amongst them will be found some that exercise pure lateral force; others with rotative action; whilst some, again, combine both these highly necessary mechanical qualities.

To commence with the simplest, I proceed to describe a form of appliance which is easily attached to an ordinary stay. It consists of a vertebral lever, fixed into the four bottom lacing-holes of a common stay by a small metal plate which has at either side a prolon-

Fig. 62.

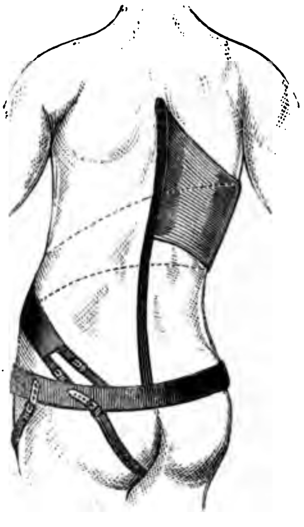


gation to secure steadiness and afford attachment to the extremities to two webbing straps. About the centre of the stem, and in coincidence with the arc of dorsal curvature, a deep webbing band is fixed, which passes across the front of the body and is secured to the plate which holds the stem in the stay-holes.

This form of instrument is extensively used in India, where its lightness and facility of concealment offer considerable advantages, and acts upon the spine by producing a constantly tractile force against the highest point of the dorsal curve, whilst the lumbar is re-acted against by the stiffened substance of which the stay is made. Its greatest advantage consists in the ease with which such an apparatus can be adapted to the ordinary stay, in such a manner as to be perfectly unobservable by any one but the wearer. It is of the greatest possible value in cases of slight or incipient distortion, as, since the webbing-band always acts against the convexity of the curve only, respiration and all the other ordinary thoracic functions are perfectly unimpeded.

The next form of instrument is based upon similar principles, but owing to there being no counteracting influence on the opposite side of the support, it is calculated to prove highly injurious to the patient who wears it. As it has, however, been strenuously recommended by several writers on spinal curvature, it is figured in these pages; although I feel assured that I shall not find much difficulty in showing the mischievous character of this invention: to do which, I must first describe its form.

FIG. 63.



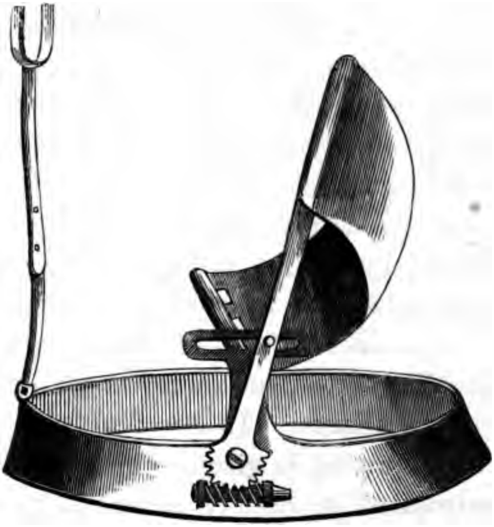
A deep pelvic belt which encircles the hips has an oblique vertebral stem attached to it.

At the upper part of this lever, and corresponding with the highest point of the dorsal curve, a webbing band passes around the shoulder and across the abdomen, where it is fastened to the pelvic-band in front. In order to prevent the pelvic-band from horizontal displacement, a leather strap is passed around the left thigh. The slightest observation of the diagram will show, that directly force is exercised upon the dorsal curve the concavity of the lumbar deflection must inevitably be increased, and consequently, that of the lower arc of distortion. Thus, even admitting it to be possible for the upper curve to become diminished by such treatment, which is highly problematical, it could only gain at the expense of an increased lower distortion, through there being no counteraction established on the lumbar surface. This invention bears the name of M. Hosard and Tavernier's "Belt," both claiming its invention; but neither need be proud of it as a triumph of mechanical skill in the treatment of spinal curvature.

Another apparatus, similar in principle and also marred by the mechanical error just pointed out, is that known as Mr. Lonsdale's

"Spinal Machine," which is evidently but a modification of Tavernier's plan of procedure. The following is a drawing of it, taken from the second edition of his work on "Spinal Curvature," p. 81.

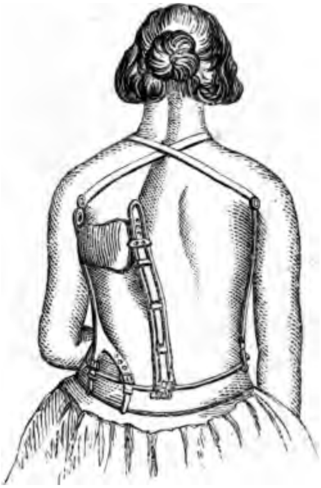
FIG. 64.



One advantage possessed by this appliance over its prototype, is the adaptation of a lateral crutch to the side corresponding with the dorsal concavity, by which means tilting of the pelvic band becomes much lessened; but there is still no provision made for encountering the certain increase of the lumbar curve, should pressure only be made upon the apex of the dorsal arc. There cannot be the least doubt but that the use of this apparatus, in a case of double lateral curvature, could only be followed by mechanical failure; for, as it is well known that each curve tends to antagonize its opposite deflection, so diminution of one arc of distortion, unless simultaneously effected with that of its equivalent on the other side of the spinal column, must lead to undue rectification, or rather to a decrease of one deformity at the expense of increasing the other. The principle embodied in this kind of apparatus being so decidedly false, it is surprising to find it still adopted, and moreover set forth as a modern appliance. In proof of which the following drawing is given, which represents an instrument powerfully advocated and in constant use. It will be perceived that with the exception of substituting a metal plate for the webbing band, it is precisely similar in error as in structure to the apparatus mentioned at page 205.

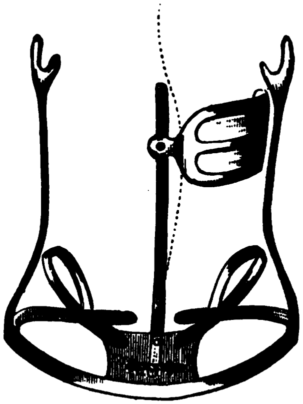
Another form of instrument, depending for its mechanical value upon the force exercised against the dorsal arc, is one which, more than any other, has, on account of its light construction and simple form, been adopted by some of our most eminent surgeons. It was invented by the late Mr. Eagland, a clever London mechanician; and apart from the error of only counteracting one curve, instead of seeking to antagonize both, deserves the highest credit. It is composed, as will be seen by the diagram, of a well-fitted pelvic band, with two lateral supports for the arms. At its posterior pelvic centre a metal plate is fixed,

FIG. 65.



giving attachment to a shoulder-plate and vertical lever, which has a horizontal screw for the due adjustment of mechanical pressure.

Fig. 66.



So long as the dorsal curve is primary, or the lumbar offers no considerable degree of prominence, this instrument answers well; but if perchance the dorsal curve has secondary origin, then the evil mentioned as pertaining to an instrument having but one vertebral plate infallibly arises, and retrogression, instead of improvement, invariably results.

Before dismissing those appliances which act purely and solely on the dorsal arc, it must not be forgotten that, in the event of the dorsal curve originating first, these instruments, although faulty in true scientific value, lose a great deal of their mischievous activity. This circumstance fully accounts for the apparently inexplicable cures which we occasionally hear of, as consequents of the adoption of these imperfect mechanisms. Even if it be taken for granted, however, that the dorsal curve has in such cases been the primitive one, the treatment would have been accomplished in less time if reactive influence were exerted against the lumbar distortion, than if so important a point of counter-resistance to the pressure established on the highest point of the dorsal curve were overlooked.

In the next form of instrument I feel called upon to describe, I have no scruples in condemning its principles, as it happens to have been invented by myself; fortunately, I have long since discovered the weak point of its original structure, and remedied it effectually. The instrument was especially devised for overcoming rotation of the vertebral column, as this peculiar condition of distortion invariably presents itself, in a greater or less degree, in *every* case of lateral curvature.

Mr. John Shaw, with characteristic sagacity, described lateral curvature as "serpentine."

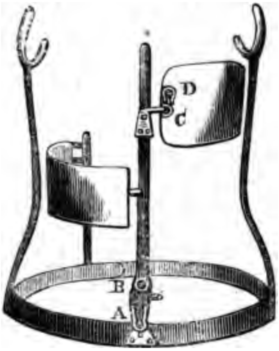
Dr. Dods specifically states that the spine in such cases is rotated.

In the present day the same opinion has been re-asserted, and it was to carry out these views that I devised the apparatus now about to be described.

The instrument consists of a pelvic band having two lateral uprights, and at the back of the pelvic band a vertebral stem, sustaining a shoulder-plate. It is, however, in the construction of this back lever and shoulder-plate that the ingenuity of the apparatus exists.

At the base of the back lever, where it joins the pelvic band, two centres of movement are placed, one (A) in an anterior, the other (B) in a lateral direction. Thus, on moving the former, pressure of the plate against the shoulder is induced in an anterior direction, and on moving the latter, a lateral resistance against the ribs is engendered. The plate itself also has two centres of movement; one (C) corresponding with the horizontal rotation of the ribs on the spine, and the other (D) moving the plate in a vertical direction around its centre of attachment. The combined action of these movements is first by means of the horizontal shoulder movement (C) to grasp and re-rotate the ribs in an anterior direction; secondly, to induce lateral resistance to the curve by the movement (B) at the base of the back lever; and thirdly, to depress the shoulder itself by the action of the vertical axis (D) in the shoulder-plate. As I gave considerable pains and attention to the invention of this instrument, its weak points soon began to render themselves apparent when adopted under my own observation. To render its peculiar imperfection clear, however, I must

FIG. 67.



give an explanation of the effect which follows any attempt to rotate a deformed spine, without guarding properly against mechanical reaction upon the human thorax.

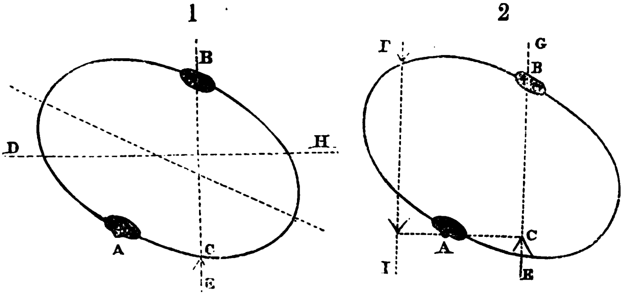
By rotation of the spine, that condition is generally understood wherein the ribs move on the bodies of the vertebræ in a backward direction; but as no deviation can ever occur in the spinal column, either transversely or laterally, without establishing a compensating curve in an opposite direction, so whatever amount of rotation takes place in the ribs at one portion of the spine (say for instance, in the dorsal), must meet with an equal amount of displacement, but in an opposite direction (in the lumbar region). The spine is, therefore, truly serpentine, and presents a posterior enlargement of the costæ or ribs in the dorsal region, coincidently with a similar protuberance at the lumbar vertebræ.

In addition to this, the upper portion of the thorax, which in its natural condition forms in its transverse plane an ellipse, the longest axis of which exists between each side of the body, changes its direction, and assumes a new shape, as in the accompanying sketch.

Fig. 1. A represents the spine, ↑ the point

where the plate of the spinal instrument has its horizontal movement; B the sternum.

FIG. 68.



C the rotated costæ or ribs in the dorsal region on which the rib-plate of instrument rests; D H the original axis of the thorax.

E B the direction of force given to the ribs when the apparatus I have described is brought into action.

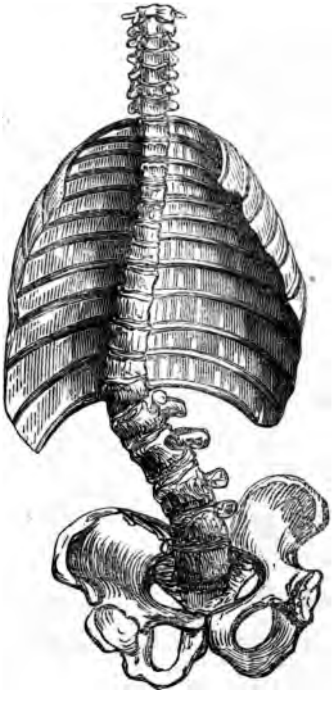
It is therefore evident that when this *single* force, E B, is brought into operation for the purpose of rotating the displaced ribs into their normal position, the entire thorax becomes thrust forward without in the least degree diminishing the curvature against which the mechanism is supposed to exert itself; so that instead of the ribs rotating around their vertebral axis, A, they will advance, accompanied by the whole dorsal vertebræ, in the line E B.

To meet this evidently weak point, I have, in the modified construction of the apparatus, employed a carefully devised plate F, Fig. 2, which rests against the antero-lateral surface of the thorax, and in a direction, F I, calculated to re-act against that of the posterior shoulder-plate, E G. By this means positive re-rotation of the spine at A can be properly secured; for as the distance between A I and A C are equal in relation to the point A, and the forces employed—viz., F I and E B, are in opposite directions, the ribs are re-rotated around their vertebral axis, which is the object to be accomplished.

To prove that the spine undergoes rotation in both directions—viz., in the lumbar and dorsal regions, I can refer my readers to a specimen of double lateral curvature, accompanied by severe rotation, now in the museum of St. George's Hospital.

In this case the vertebral bodies composing the upper segment of the dorsal curve are rotated backwards; those forming the inner segment of the lumbar deflection are also rotated backwards, whilst, between the centre of the two curves, an anterior rotation of the vertebral bodies is exhibited. The following sketch taken from the specimen will explain the correctness of this statement, and illustrate the fault committed in employing rotative force against the upper curve, without securing counteraction at the anterior surface of the ribs on the left side of the sternum.

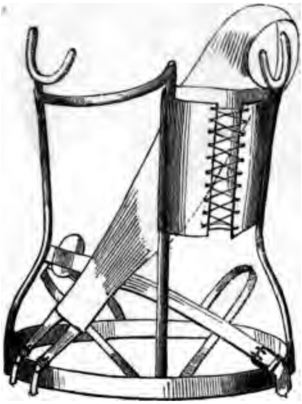
FIG. 69.



The next form of apparatus is one invented by Mr. Laurie, and calculated to prove of great service in cases of ordinary double lateral curvature; one of the greatest proofs of its merit being that it has been extensively adopted by Sir B. Brodie: for whose patients, and at whose wish, I have applied a large number of these instruments.

It consists of a padded pelvic band, with two semi-lunar bands passing over the crura of the ilia. To this pelvic band two lateral uprights and a vertical stem are attached; the latter being connected to the left upright by a horizontal bar passing across that shoulder, which gives stability to the whole mechanical

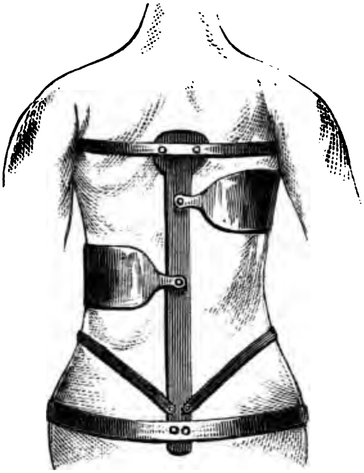
Fig. 70.



frame. Passing over the right and uplifted shoulder is a lever cap, having two straps fastened obliquely to the pelvic belt. Against the enlarged ribs there rests a lacing band, very softly padded, the pressure of which can be augmented at will. Over the centre of the lumbar curve a pad and oblique strap is placed, by the tightening of which diminution of the curve is brought about. In order to prevent the body from escaping out of the apparatus, and thus negativing the surfaces of posterior resistance, a soft linen band crosses the chest, and renders the whole apparatus compact and effective. This form of instrument can be readily concealed beneath the tightest dress; hence, in addition to its scientific usefulness, it is generally liked by patients.

A very simple apparatus, intended to act against both arcs of lateral curvature, was suggested by my predecessor, Mr. Sheldrake; and has evidently formed the prototype of a large number of modern inventions. It is constructed as follows:—a pelvic band, shaped to the hips and resting upon the ilia, gives attachment to a vertebral stem, which terminates superiorly in two horizontal arm-pieces, sliding upward in a vertical direction. Fixed to the margins of the vertebral stem are two light padded plates, which, being tempered like a watch-spring, grasp the body and create pressure against the arcs of both lumbar and dorsal curves—much as the human hands would, if

FIG. 71.

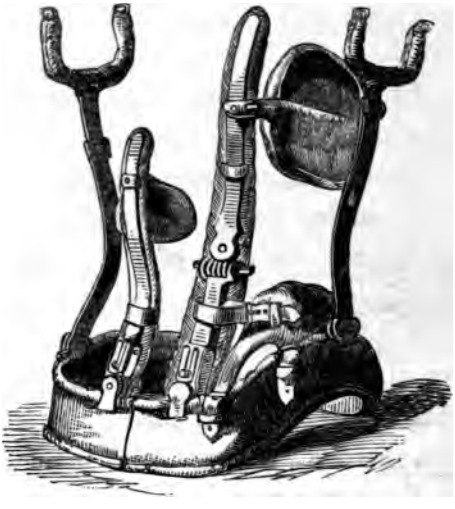


employed to press the enlarged sides of the body in opposite directions. To bring this instrument into proper action, the left arm-piece should be raised above the level of the right, so as to uplift the depressed shoulder; whilst the two plates should be gradually tightened up to the highest point of pressure that the patient can bear without discomfort. This extremely light and ingenious piece of mechanism is constantly employed by me in cases of slight or incipient curvature, and with the best possible results.

In order to secure the unquestionable advantage of acting upon each arc of lateral curvature simultaneously, a large number of appliances, based upon the plan just described, have been adopted. They are all, more or less, mere modifications of that originally invented by Mr. Sheldrake. Sometimes, however, this desire to diminish curvature, by compression of the lateral arcs, has been carried to a point highly calculated to awaken feelings of surprise at the evident want of mechanical knowledge displayed in their arrangement. Amongst the most prominent of these plans may be mentioned an instrument which, whilst taking advantage of the original idea of lateral compression, carries it out with a degree of violent force never calculated by the first inventor.

This appliance consists of a very deep and clumsy pelvic band, having a vertebral stem fixed to its posterior centre, which stem supports a plate resting against the lower or lumbar curve. The vertebral stem is moved laterally by a ratchet-screw. Close to this ratchet-screw another back stem is similarly attached, which holds a plate acting against the upper or dorsal curve, and moved laterally by a ratchet-centre like the first stem.

FIG. 72.*



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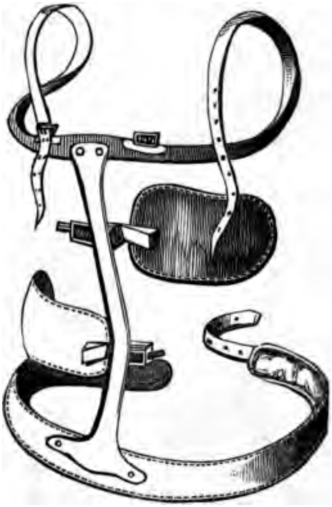
* This drawing was taken from an apparatus which I removed from a young lady of fourteen years of age. It weighed 8 lbs. It is needless to say I applied a much lighter instrument with far better effect.

Two lateral uprights, as in almost every ordinary form of spinal instrument, support the weight of the arms. The arrangement of the two ratchet-joints having no mathematical relation to the centre of the vertebral curves, as in the instrument described at Fig. 45, only serve, when brought into action, to force the ribs towards the spine in a purely lateral direction. But as the resistance offered by the ribs is less than that presented by the spine, it but too frequently happens that the enormous force exerted by so powerful an instrument induces a flattening of their surfaces, and I have seen a perfectly sharp ridge upon the ribs at their angles, induced by constant application of this special kind of mechanism. Another considerable objection is, that since the lower ratchet moves, not only the dorsal plate but the axis to which the dorsal plate is fixed, a disturbance of the fixed centre declared to exist in all double vertebral curves (vide Fig. 45) occurs, and the power of the instrument becomes expended in lessening the lateral space of the ribs instead of in expanding the vertebral curves. I know of no apparatus calculated to demand greater mechanical caution in its use than this one; for although under heads and hands accustomed to watch, and as far as possible counteract, those abnormal disturbances which will result from the movement of the ratchet-joints already described, cases may be apparently improved, yet if the instrument is used injudiciously, or rather in obedience to its form and constructive intention, compression of the ribs and its attendant evils will inevitably follow. The few remarks made upon the salient faults of this spinal instrument will, it is trusted, lead those who now adopt it as a useful piece of mechanism, to consider whether the strictures passed on it are well founded or otherwise, and to act for the future in accordance with their decision.

Another similar form of instrument, acting by lateral compression, has been largely employed in spinal treatment. It consists of two crutches fixed to a pelvic band with a vertebral lever attached to the sacral centre. On either side of this "artificial spine" a plate is arranged, the upper resting against the arc of the dorsal, the lower against the lumbar curves. Motion is given to these plates by means of a horizontal screw, which, by being thickened in the form of a wedge at its end, produces a certain amount of rotation; or rather, *theoretically* does so, when applied to the ribs. Upon carefully examining the action of this apparatus, the merest tyro in mechanics will discover that, as the spine possesses anterior mobility, whatever amount of force is exercised in forward direction by the plates, must of necessity drive or push the body out of the apparatus, and end by producing lordosis, or hollowing of the lumbar vertebræ, instead of conquering the lateral deflection for which it is intended to be used. This instru-

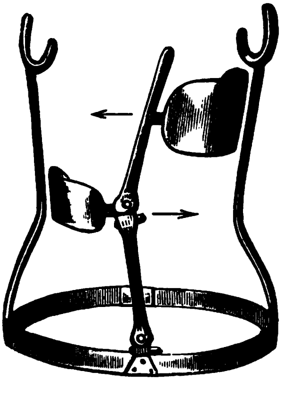
FIG. 73.



ment, like the one just described, exhibits the lamentable amount of mischief that must ensue from an employment of ill-devised mechanism.

In order to prove that an instrument may be made to act by lateral compression in an efficient and scientific manner, I must quote the following, which is one of my own invention. Its object is to secure mechanical movement from those points which correspond with the fixed centres, observable in all cases of lateral curvature which are in the sacro-lumbar region, and at the axis arising from the

FIG. 74.*



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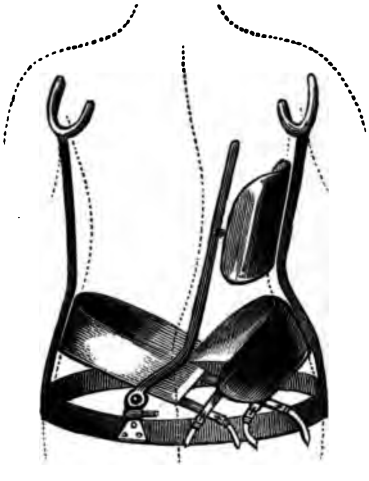
* I first devised this apparatus for a patient of Mr. Fergusson's, in whose case it succeeded in perfectly straightening the spine.

junction of the lumbar and dorsal curves. To explain how this is done, I will describe the instrument. It has a pelvic band and two lateral uprights, with the usual form of back stem. This vertebral lever has two axes: one coincident with the point of junction of the upper and lower spinal curves; the other with the sacro-lumbar articulation. A padded metal lumbar plate is fixed to the former centre; and another, which rests upon the enlarged ribs belonging to the dorsal curve, is arranged on the opposite side. On moving the sacro-lumbar centre, the plate on the left side produces diminution of the lower curve; and on bringing into action the ratchet which corresponds with the junction of the lumbar and dorsal curves, a lessening of the dorsal arc ensues: thus the spine becomes gradually restored with an economical expenditure of mechanical power. For cases in which the spine has recently yielded, this form of apparatus is of great service.

Sometimes, in old standing cases of lateral curvature, so great an amount of costal displacement exists as to require the application of an uplifting power to the lower segment of the curve. I have invented an extremely simple plan for gaining this desideratum, which is thus constructed :—

Instead of the back stem being made to represent a vertical line, it is formed with an abrupt curve in its lower portion, the effect of which is to produce an uplifting of the plate whenever lateral force is engendered. For, as

FIG. 75.



the centre is placed beyond the line of th vertebræ, an increase in radius occurs, so tha the costal plate, instead of travelling in purely horizontal direction, rises upwards, carrying the enlarged ribs with it, and thus diminishes the area of the dorsal curve. A webbing band passes over the left hip, and secures a certain amount of reaction against the lumbar deflection.

The next instruments which I shall describe are based upon a principle entirely my own; but which offers the rarest of advantages in permitting free muscular movement to take place, during the whole of the period for which the apparatuses are worn. The cause which led to their invention was the necessity that appeared to exist for such an application of mechanical power to the treatment of spinal curvature as would admit of perfect bodily freedom. Every form of instrument with which I am acquainted limits muscular motion, and in many cases entirely suspends it. To conquer so formidable a condition over-taxed all my powers of invention, until, after making a long series of mechanical experiments, I at length arrived at the conclusion that in the retractile force of vulcanized india-rubber was to be found an agent capable of accomplishing all that could be scientifically desired.* When it is remembered that the spine owes its perpendicular position largely to the antagonistic force of opposing muscles, it may readily be comprehended that a substance acting so analogously with muscular traction as india-rubber, offered a means of remedying spinal curvature in a manner which, being in imitation of, might well be aided by nature. To apply this material, as power is exercised by the vertebral muscles, became henceforth my aim: how it has been achieved the following inventions best demonstrate.

The first consists of a pelvic band giving attachment to a vertebral stem and two horizontal arm-pieces.

In the arrangement of this vertebral stem the whole mechanical merit consists. It is jointed in such a manner as to assume any position which the body offers, whilst two plates, one for the dorsal, the other the lumbar curve, are attached to its sides. Fixed to the left arm-piece, which also moves upon a vertical centre, is a strong vulcanized india-rubber cord, which passes over a roller in conjunction with the dorsal plate, and again over another roller attached to the lumbar plate, and is finally fixed to the pelvic band. On drawing

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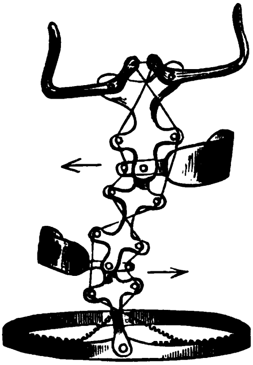
* For nearly eight years I have applied this principle of india-rubber traction to the treatment of club-foot and spinal curvature with the most beneficial results.

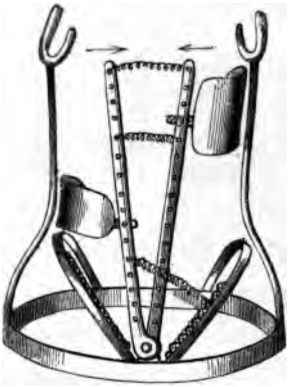
FIG. 76.



this cord tightly downwards by a buckle and strap, it instantly acts upon the yielding artificial centres, and induces powerful and equal compression of the lumbar and dorsal curves. Notwithstanding, however, the force employed is considerable, it yet, from its elastic and resilient character, permits the body to move freely in every direction. It is therefore by the persistent action of the elastic force that the vertebral curves are gradually compelled to diminish, and a restoration of natural equilibrium is at once established. With this form of instrument respiration takes place freely, and the patient feels hardly any restraint from its use.

Another form of spinal support, based on the same plan, is thus constructed: its employment being intended for cases of average severity. A pelvic band encircles the hips, whilst two lateral uprights remove the superincumbent weight of the head and shoulders from the spine. On each arc of curvature a

FIG. 77.



metal plate rests, held by two levers which move freely on a common centre.

By fixing india-rubber cords from the centre of each plate to the adjacent parts of the instrument, compression of the deformed surfaces results; but with the advantage, attributed also to the former instrument, of allowing the patient to breathe and move about freely during the whole period of treatment.

I constructed six distinct forms of apparatus on this elastic plan, and found that they all fulfilled their purpose in a certain and efficient manner.* As, however, my space is limited, I refrain from giving drawings of the other four, as they were only modifications of those just described. It cannot, however, fail to strike the professional reader that, with a substance so easily regulated as india-rubber, any amount of mechanical force can be gained without any fear of producing abrasion and annoyance to the skin of the patient; whilst, from its persistent action, the antagonizing muscles and ligaments opposed to the restoration of vertebral equilibrium, must eventually become fatigued, and thus yield to the new but artificial power adopted to negative and overcome their resistance.

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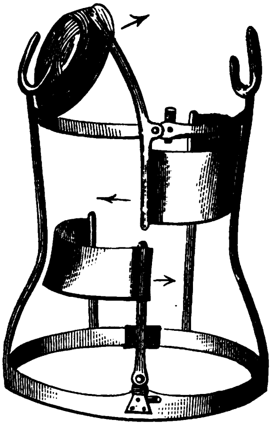
* I am deeply indebted to Mr. Erichsen for kindly affording me an opportunity of trying this plan of elastic force.

Before dismissing that branch of my subject which refers to the mechanical treatment of double lateral curvature, I intend to give a description of three forms of spinal instrument which have proved highly valuable for redressing the vertebral arcs on sound and scientific principles. The first is formed as follows:—

FIG. 78.



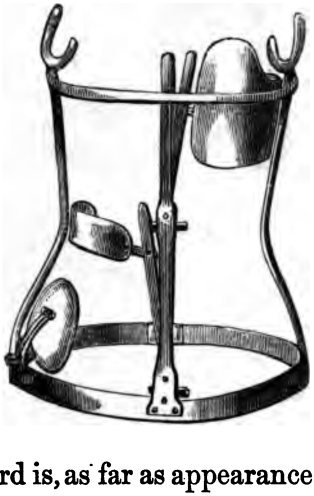
A pelvic band and two lateral uprights form the base of the structure; the uprights being connected together at their highest point by a horizontal band of steel passing across the shoulders. In the centre of this band two ratchet axes are fixed, one giving an uplifting movement to a lever which holds a padded ring through which the left arm of the patient passes. Another ratchet-centre, immediately below the first, moves laterally. A webbing band passes over the dorsal curve, and is firmly fixed to a front stem. A third ratchet-centre occurs in the middle of the pelvic belt, which moves a lever fixed to a webbing band passing over the lumbar curve; and this webbing band is also fixed to a front upright. The action of this instrument is simple, but excellent; for upon moving the upper shoulder ratchet, an uplifting of the left arm and expansion of the dorsal curve ensues. On moving the lower shoulder ratchet, a tightening of the webbing band and diminution of the arc of dorsal curve takes place; and on moving the pelvic ratchet, a depression of the lumbar arc is secured. These being the whole of the conditions required to restore a deflected spine to its original position.

The second form of instrument, although

figured and partially described at Fig. 45, is so important in mechanical value as fully to justify a more complete detail of its construction and intended purpose. Its arrangement is based upon the mathematical theory there expounded, which maintains that, in order to act, with due scientific economy of force, upon double lateral curvature, the axes of the apparatus must coincide with those centres which the spine naturally presents in its distorted condition, and that these are the sacro-lumbar for the production of the lumbar deflection, and the point of junction between dorsal and lumbar curves for the creation of the dorsal distortion. Having determined that such centres always exist, and may by proper process be readily discovered, the merit of the instrument becomes at once apparent. Its parts consist of a padded pelvic band encircling the hips, and affording an attachment on each side to a lateral crutch for the arm. At the posterior centre a perpendicular lever, representing the direction of the spinal column in its normal condition, is affixed, being firmly attached to the uprights by a transverse bar passing across the shoulders and giving stability to the whole artificial frame. At the base of this vertebral stem, and coincident with the sacro-lumbar articulation, a ratchet lever is placed, holding a padded plate, which takes its bearing against the arc of the lower or lumbar curve. At that point in the vertebral stem which agrees with the junction of the two spinal curves, another ratchet lever and plate are attached, which plate rests on the highest point of the dorsal curve. Thus the direction of force becomes equal and opposite; but from one plate being above the other, and both coincident with the displaced surfaces, their resultant action is to uplift and unfold the abnormal spinal deflections. It might, with some show of scientific knowledge, be advanced, that the centre of a curve is that point around which its extremities are grouped, and that therefore the lumbar and dorsal axes should more properly be described as existing at their highest surface of curvature, rather than the points I have determined. If, however, reference be made to Fig. 45 it will be seen that the centres I and G there established, are really the points around which the spine has moved in the construction of the two arcs of curvature, and therefore perfect propriety of reasoning is established for the maintenance of these two points as the centres of mechanical action.

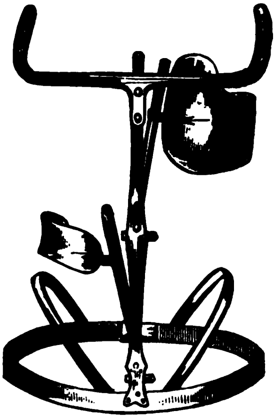
When this instrument is applied, and the straps properly secured, the arm-pieces should be raised to such a degree of elevation as to remove, as far as possible, the superincumbent weight of the head and shoulders from the spine. It is then necessary to tighten the two plates in such a manner that they mutually compress the surfaces against which they rest. By this means the whole spine becomes subject to the control of the instrument, and all chance of displacing the supporting surfaces ends. Sometimes, however, one of the ilia may be so much displaced as to prevent the lumbar plate from acting perfectly. For overcoming this condition a very ingenious arrangement has been suggested to me by Mr. Brodhurst; it consists in the application of a padded plate resting against the lateral surface of the ilium, and acting by means of a ratchet-joint in a direction calculated not only to depress the upraised side of the pelvis, but, what is far more important, entirely prevent any displacement of the mechanism, and increase greatly the force of the upper or dorsal plate. This is the only instrument for double lateral curvature with which I am acquainted, by which the pelvis is specially acted upon, although all professional men must have felt the want of some such mechanical power when treating severe cases of scoliosis.

FIG. 79.



The third is, as far as appearance is concerned, an improvement upon either, and intended to be used where the patient is anxious for the mechanism to be concealed from observation. Its only difference consists in the absence of lateral uprights, and the substitution of a horizontal arm-piece. It is shaped thus,

Fig. 80.



and presents the same advantages as those enlarged upon when describing the second instrument.

These conclude all that are well known as appliances calculated to afford aid in the treatment of spinal curvature. There are, however, endless modifications of such devices, but I have carefully selected those which afford the best illustration of proximate principles. One and all act by expansion of the extremities, combined with compression of the vertebral arcs by lateral and rotative forces: this plan of arrangement being the most scientific and philosophical that can ever be adopted for the ameliorative mechanical treatment of double lateral curvature.

CHAPTER XII.

APPARATUSES ACTING IN UNISON WITH GYMNASTIC AGENCY.

GROUP IV.

The fourth division of appliances for the treatment of double lateral curvature, embraces those which have been especially devised for strengthening the muscles of the spine during the use of gymnastic movements. Within the last twenty years many attempts have been made to reduce those bodily exercises to the principles of a science, which, in cases of spinal deformity, have hitherto been used with success. In these efforts, Ling, Georgii, Chiosso, Roth, Heine, and others have largely aided. It has long been apparent to all scientific observers, that although it is possible by the influence of constant mechanical power to compel a distorted body to resume its normal form, yet, as soon as the compulsory means are withdrawn, relapse of the restored parts rapidly follows.

To meet this difficulty much patient research has been undertaken, and the result abundantly proves that the readiest method of not only straightening, but restoring the spine to its pristine strength is to be found in a combination of mechanical support with gymnastic movement.

Knowing from experimental research the importance of this arrangement, I personally visited and carefully inspected all those orthopædic establishments of celebrity in Vienna, Dresden, Berlin, Stutgard, Caansdat, Munich, Paris, Brussels, &c., for the purpose of discovering to what extent this combination of mechanical with gymnastic treatment was employed.* I found, with hardly an exception, that the successes so frequently met with abroad had their proximate origin in the care which was taken to maintain the good effect resulting from the use of a mechanical apparatus, by frequently exercising those muscles particularly implicated in the deformity. The means employed for doing this were generally of the simplest order, consisting of a horizontal hand-swing, an inclined ladder, a few parallel bars, and some knotted ropes hung from the ceiling. With these simple mechanical aids, every possible variety of gymnastic movement were performed. As, however, the constant presence of a master is imperative in these institutions, and each of these advocated his especial system of exercises, it is unnecessary for me to attempt here any explanation of the various plans pursued by them, more especially as I have dealt with this subject elsewhere.* My present object is to explain, as briefly as possible, the nature and construction of such gymnastic appliances as are invaluable adjuncts in the treatment of vertebral distortions, and to illustrate their ordinary uses.

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* On returning to London I had a gymnasium built, capable of accommodating about fifty patients, in order that the advantages assigned to muscular exercises might be practically tested.

Amongst the simplest may be mentioned the horizontal hand-swing, which is constructed as follows:—Two ropes of equal length, firmly secured to the ceiling of a room, carry at their lower extremity a polished wooden horizontal rod, sufficiently thick to be grasped firmly by the hands of the patient when standing on tiptoe. This form of apparatus is equally intended to exercise the muscles of the spine and chest, and its value arises from the necessary employment of a considerable amount of physical power in swinging the body backwards and forwards, whilst suspended by the hands from the horizontal rod, which leads to an increase of power being given to the muscles so exercised. When, however, spinal curvature has assumed a permanent character, the purely horizontal bar seldom accomplishes any satisfactory change. For these latter cases I have devised an especial modification of the hand-swing, so constructed as to induce an expansion of the arcs of spinal curvature, whilst those muscles which exist within the concavities are more powerfully exercised than their stronger antagonists. By this proceeding, only those muscles previously debilitated, and hence lessened in tractile power, are brought into play; thus the objection constantly urged against every variety of gymnastic treatment, namely, that it brings into operation those muscles which are already too strong, is met and set aside by the exhibition of a system which tends to restore muscular equilibrium, by restraining the action of the strongest muscles whilst the weaker are being developed. To accomplish this, four ropes and two horizontal rods are required, arranged as represented below.

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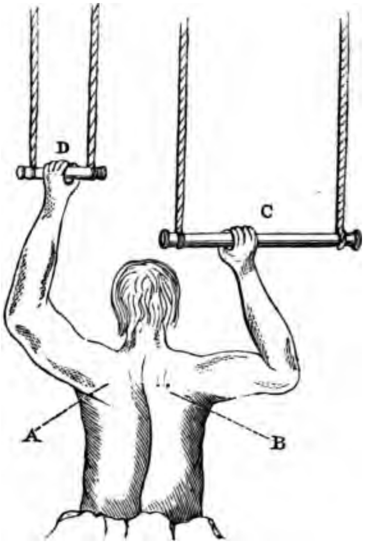
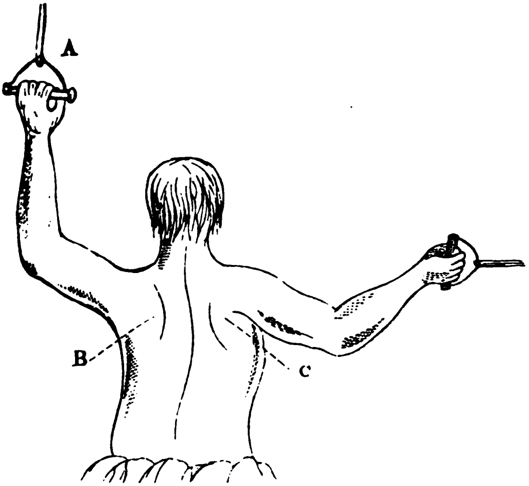
* "Localized Movements; or, Gymnastic Exercises applied to the Treatment of Spinal Curvature and other Deformities." By H. H. Bigg. J. Churchill, New Burlington-street.

FIG. 81.



When the patient begins to swing the body, the arm on the concave side of the deformity is upraised beyond the level of the opposite hand, and thus produces a considerable amount of activity in those muscles (A) which act within the concavity of the curve; whilst, owing to the flexed and almost rigid position of the depressed hand (C), those muscles (B) situated on the convexity of the curve are left almost entirely at rest. By sedulously maintaining this system of exercise, combined with a form of mechanical support figured at page 218, vertebral equilibrium becomes gradually restored, whilst the health of the patient is invariably improved, owing to the daily use of this simple localized physical exertion. This kind of swing is employed in cases of ordinary permanent curvature; but where a still greater amount of distortion exists, it is customary to advise the use of an appliance which consists of two wooden handles fixed to powerful india-rubber cords. One of these cords gives a vertical, the other a horizontal power; the reason for this being, that the hand (A, Fig. 82) corresponding with the concavity of the dorsal curve (B) should be upraised, whilst that which belongs to its convexity (C) should be laterally extended. By this means the attenuated muscles situated within the concavity of the dorsal curve are exercised without danger of opposition from their stronger antagonists. This diagram will fully explain the importance of such an arrangement.

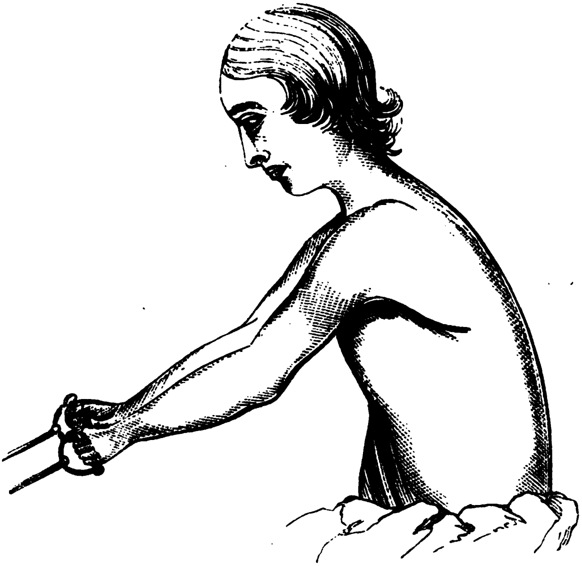
FIG. 82.



When the left hand is drawn downwards it brings into action the muscles belonging to the dorsal concavity, while, as the right hand firmly grasps the horizontal elastic cord, those muscles situated upon the convexity are held in a comparatively quiescent state. If the left hand were not upraised, holding the right one horizontally would increase the action of the muscles on the convexity of the upper curve; but owing to the oblique position given to the shoulders these muscles remain at rest.

In cases of double lateral curvature, arising from debility in the erectores spinæ muscles, the appliance generally employed assumes the form of two strong elastic cords secured to the floor, carrying handles so arranged that the patient has to stoop forward to reach them. On uplifting the body, the longissimus dorsi and sacro-lumbalis muscles are powerfully exercised, which is the object intended.

Fig. 83.



This movement being somewhat similar to that employed by stonemasons while using their saw, has received the appropriate but extremely inelegant title of "the top-sawyer exercise." Its being, however, quoted under this appellation in more than one orthopædic work, may be considered as entitling it to a place amongst anatomical apparatuses.

These inventions are more or less valuable according to the cases for which they are employed; but unless used with a certain amount of judgment and care, there is some risk of their accidentally increasing the curvature, by unduly exercising muscles already too strong.

To guard against the possibility of this occurrence, I have invented a portable gymnasium capable of being so arranged that the patient cannot possibly err, but must infallibly derive whatever benefit muscular movements are capable of affording. An additional advantage is, that whilst the same apparatus is applicable for every form and variety of spinal distortion, it remains available as a gymnasium in which those member of the family who have no need of exercising their muscles for spinal curvature, can yet in crease their health, symmetry, and strength, by amusing themselves with the endless but simple exercises for which it is adapted. Notwithstanding that I have examined every form of gymnastic apparatus of any Continental or home celebrity, none, except the one which I am about to describe, seem to meet the most important of all conditions—that of making the body itself the centre from which all the movements emanate.

Again, I have never seen any attempt made to control, and consequently diminish, the curvatüre whilst exercises are being taken, save in this beautiful and ingenious piece of mechanism. Before describing its construction, I must again remind my readers that the object sought by those who use gymnastics as an ameliorative agent in cases of spinal distortion, is the rendering those muscles which have become debilitated by disease, stronger and more vigorous; whilst those already abnormally increased in power are, as far as possible, to be restrained from action. More even, however, is necessary than these conditions; for unless, whilst the exercises are being undertaken, the ligamentous structures of the spinal column are also extended, and the bodies of the vertebræ gradually replaced in position by lateral resistance applied to the ribs, all kinds of muscular movements are likely to prove futile, and simply tend to waste the patient's time, without conferring the slightest benefit as regards the curvature.

When planning the apparatus which I am now advocating, I felt persuaded that the body must be placed in the centre of the mechanism, for by this means alone could it become a kind of fixed point around which the various exercises might be brought to bear. I also judged that the arcs of spinal curvature must be expanded concurrently with the bringing into action of the muscles placed within their concavities, and that the whole spinal column should be slightly extended so as to remove the vertical weight of the head and shoulders from the intervertebral cartilages.

To accomplish the first requisition, the apparatus is made to receive the patient in its centre in a semi-perpendicular posture, that is to say, neither sitting nor standing; but with the pelvis resting against an inclined seat, and fixed to it by a padded band, which thus secures firmness of resistance in anticipation of the exercises about to be taken.

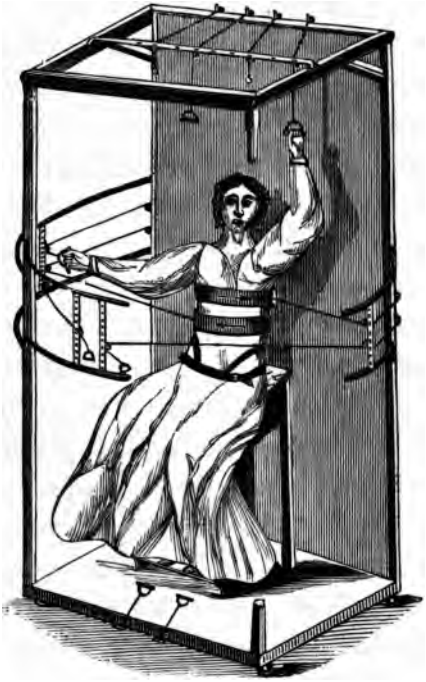
To carry out the second idea, I have arranged two webbing bands, one pressing upon the arc of the dorsal, and the other upon that of the lumbar curve, which bands are fixed to opposite sides of the mechanism, and held there by elastic cords, communicating with leaden weights proportioned to the resistance offered by the several curves, so that the patient moves and breathes freely, notwithstanding that the spinal arcs are compressed at their centres, and expanded at their extremities by the weighted elastic bands. And lastly, I secure the head of the patient in a little padded chin-strap, fixed by an elastic band to the upper part of the apparatus; the effect of which is to entirely remove the weight of the head from the inter-spinous substances, and thus aid the lateral webbing bands in expanding the arcs of curvature. In these arrangements, the body being placed in the centre of the mechanism, permits it to preserve a perfect degree of equilibrium and to approximate itself as nearly as possible to a straight line, which in a distorted figure is one of the first points to be considered.

By reacting against the natural tendency which a deformed spine possesses of increasing its arcs of curvature, by means of lateral force applied to their highest points, the muscles placed on the convexities of the curves become relaxed, and their resistance to their weaker antagonists proportionately diminished. And by extending the spine between the occiput and pelvis, as is effected by the chin-strap already described, a certain amount of tension against the debilitated muscles situated within the concavities of the curves is engendered, and an additional physiological stimulus imparted to their structure, by calling their retractibility into operation.

These several points are perfectly novel in the treatment of spinal curvature by gymnastic exercises, so that the "portable gymnasium" will probably place in the hands of the medical profession a new mechanical agent for dealing with deformities of the spine, always presupposing that localized movements are of value in such cases, which time alone can satisfactorily determine, owing to the short period that has passed since their introduction into the surgico-mechanical practice of this country.*

I will now proceed to give an illustration of

Fig. 84.



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* I am under great obligation to Mr. Fergusson, Mr. Paget, Mr. Ernest Hart, Mr. Nunn, Mr. Canton, Dr. Semple, Mr. Holmes Coote, and several other medical men for the opportunities afforded me of testing the value of gymnastic exercises.

the mechanism, as clearly as I can, in the hope that it may lead those who approve of its arrangement to prove their conversion to my own belief in its high value by adopting and suggesting its use.

The "gymnasium" consists of a square wooden frame, having at its back a recess in which the weights and pulleys which govern the action of the respective cords are concealed, thus adding to the elegance of the structure, and preserving it from accidental derangement. Within the centre of this frame is a seat capable of being raised or lowered to suit the patient's height, with its surface so inclined that the body simply rests against it in a slightly flexed posture, being secured from displacement by a strap passing around the hips. Extending from the two front pillars are three arches of metal, one at each side, and a third in the front. These arches give attachment to elastic cords, which communicate with pulleys hid in the back of the apparatus. Connected with these cords, handles are arranged on each side, and in the front. Over the head other handles are fixed, likewise attached to pulleys, there being also a fixture for the chin-strap. Besides these there are two handles at the feet with pulleys. To the lateral arches, and connected with the elastic pulleys, are two webbing bands, capable of being attached or detached in an instant; which bands pass around the body and act against the curves, as shown in the drawing, page 253.

In this arrangement of pulleys, it will be perceived that the patient possesses the power of drawing the handles towards her in all directions, and consequently has every imaginable variety of movement within her grasp. Thus, for example, the hands, when extended in front, find two pulleys ready to be pulled towards the chest, and hence exercise the posterior scapular and vertebral muscles. Or if the hands are extended laterally, other pulleys are ready to be drawn towards the side, so that those muscles are exercised also. Should the hands be raised above the head, there are also pulleys for drawing downwards, exercising other muscles. Or if the patient stoops forward, handles present themselves, which are capable of being drawn upwards from the ground, and leading to an exercise already described as the "top-sawyer" movement.

These are but the simple movements; their combinations are endless: thus, one hand can be raised above the head, and the other extended laterally; or one may be advanced in front whilst the other is moved sideways. In each and every movement, the hand finds the mechanical power it requires ever ready for it.

But the most important feature is, that as the webbing bands are always acted upon by elastic weights, the movements of the arms and hands tend to unfold the spinal arcs of curvature, whilst the necessary exercise for strengthening the muscles remains unimpeded.

To give the subject scientific value, the drawing represents one of the most useful exercises in cases of double lateral curvature—viz., one arm upraised and the other extended.

It will be seen that the patient's pelvis is held by a strap to the seat; whilst over the arc of the dorsal curve, and acting in a direction calculated to diminish its enlargement, a band passes, which is attached to the side of the apparatus; another band is also placed on the opposite side of the body over the lumbar curve, and similarly fastened to the side, both being acted upon by weights accurately and skilfully proportioned to the *degree* of curvature presented by *each*. The head rests in a padded band, attached also by a carefully arranged weight to the apparatus. The left hand is perceived to be upraised for the purpose of pulling downwards a pulley, and thus exercising the muscles on the concavity of the dorsal curve. The right hand is laterally extended, so that the muscles in the concavity of the lumbar curve may be similarly acted upon.

By this method of mechanical arrangement, extension and lateral action are combined with muscular development; and this principle appears to be the most rational way of adopting gymnastics for the treatment of spinal curvature.

Whilst carefully investigating the method by which only those muscles which are actually required to be exercised should be brought into activity, I arranged the following table as a guide for the adoption of such exercises as would particularly tend to the accomplishment of the object in view.

Unless explained, it will undoubtedly appear somewhat obscure even to the professional reader.

The columns are intended to be read horizontally. Thus, under the head of REGION,

		REGION.	CERVICAL.		DORSAL.		LUMBAR.	
		On the side of muscular contraction, is created . .	Convexity.	Concavity.	Convexity.	Concavity.	Convexity.	Concavity.
Mechanical Action.	Laterally.	Direct	Rhomboideus minor. Trapezius (middle fibres).		Rhomboideus major. Trapezius (middle and lower fibres).		Latissimus dorsi.	
		Oblique	Semi-spinalis colli. Cervicalis ascendens. Serratus posticus superior. Trapezius (upper fibres).	Splenius capitis. Levator anguli scapulæ. Trachelo-mastoideus.	Complexus. Trachelo-mastoideus. Longissimus dorsi. Sacro-lumbalis. Splenius capitis.	Semi-spinalis dorsi. Transversalis cervicis. Serratus posticus superior.	Serratus posticus inferior. Latissimus dorsi.	
		Indirect		Inter-transversales. Multifidus spinæ. Complexus. Transversalis cervicis. Splenius colli.	Semi-spinallis colli. Serratus posticus inferior.	Inter-tranversales. Latissimus dorsi. Multifidus spinæ.		Inter-transversales. Multifidus spinæ. Longissimus dorsi. Sacro-lumbalis.
	Posteriorly		Interspinales.		Interspinales. Spinalis dorsi.		Interspinales. Spinalis dorsi.	

This table is intended to classify those muscles which are particularly implicated in maintaining the arcs of spinal curvature, and to explain how, by their conjoined mechanical action, they primarily induce deformity.

the division of the spine into its three parts of cervical, dorsal, and lumbar is specified.

In the second column, it states that, on the side of the spine where muscular contraction is already established, there is created either convexity or concavity in the cervical, dorsal, or lumbar region, according to the muscles implicated: it being taken for granted that the table is read in its relation to a spine already found to be distorted.

The third column indicates the mechanical direction in which the muscles exercise their action—that is to say, either laterally, direct, oblique, or indirect; and this column is subdivided into three parts, containing a list of the muscles affected, and the effects which they produce.

The fourth column is simply supplemental to the third. To render this clear, let us suppose a case of ordinary spinal curvature in which the cervical, dorsal, lumbar curves are well defined, and take the upper or cervical curve for analysis. Upon examining this curve, we should find that, on its convexity, the rhomboideus minor, middle fibres of the trapezius, the semi-spinalis colli, cervicalis ascendens, serratus posticus superior, and upper fibres of trapezius were abnormally strong; whilst on the concavity, the splenius capitis, levator anguli scapulæ, trachelo-mastoideus, inter-transversales, multifidus spinæ, complexus, transversalis cervicis, and splenius colli were also enlarged and strengthened. This state of things then would indicate that, in the exercises intended to be adopted, these muscles should be restrained from activity, whilst their antagonists ought to be as much brought into play as possible.

To accomplish this demands great care and experience; and, after all, it can but be approximately done, as by the peculiar complication presented by the muscular layers of the spine, it generally happens that, with the utmost painstaking, the smaller and deeper muscles, already stronger than they should be, are brought into play; still, as the administration of gymnastic exercises should depend upon a well-defined scientific basis, it is an indisputable fact that, with a table such as I have prepared, there is much less chance of employing mischievous calisthenic movements than if no information existed as to the direction and position of the weakened muscular substances. Fortunately, too, the deep muscles are shorter, and consequently have less leverage than the more external ones, on the action of which we can calculate.

Again, although a feature hardly within the scope of the present work, should friction and shampooing ever be judged expedient in a case under treatment, how valuable does this table become, as a means by which a surgeon may give immediate information to the rubber who comprehends anatomical terms, as to the muscles which should be especially manipulated. In this latter sense, I have every reason to hope that clearer minds than my own may be led to continue these investigations, in which case the table which I have thus studiously prepared will possibly be found of some little use to later labourers. I need hardly remark that the mechanical force and direction of each muscle named in the lists appended, have been calculated by me in a mathematical ratio. To do this, I formed artificial muscular substances, and attached them carefully to the human skeleton in its distorted form, accurately preserving the system of arrangement presented by nature, and then compared, with as great an amount of exactitude as such a process would admit of, the mechanical sums of their resulting actions.

It is also possible that the medical electrician would find this table of use, should he be desirous of imparting tone and physiological activity to debilitated spinal muscles in cases of vertebral curvatures.

To return to the subject of appliances for the employment of muscular exercises, it may be stated that a large number of very ingenious pieces of mechanism have been devised in the form of portable gymnasiums, among which may be mentioned those of Huygens, Chiosso, Ernst, Heine, and other intelligent mechanicians. They, doubtless, severally possess many valuable advantages; but as these appear to be embraced in the apparatus which I have already figured, and the pages left for further description are almost expended, it is needless to enter into details of their peculiarities in form and construction.

CHAPTER XIII.

MECHANICAL SYNOPSIS OF SPINAL INSTRUMENTS.

The last chapter completed my description of those appliances which have hitherto been found most useful in the practice of mechanical orthopraxy, especially in reference to spinal curvature. The mention of so large a number may probably be a cause of perplexity to surgeons desirous of using the *best* instrument for some particular purpose. It is, therefore, possible that the result of a considerable amount of experience in the invention and application of these devices may be of some practical professional value, if I give them in the shape of a brief summary of those apparatuses which possess the highest mechanical advantages, in relation to the various families and orders into which cases of deformity are divided. In acting thus, it must be taken for granted that it is done without the slightest intention of interfering with the opinions those of the profession who have made th treatment of deformities their "spécialité," an whose labour and researches are appreciated b all who desire to see such cases classified wit other items of modern scientific progress. Bu as I have always persistently advocated a ju division of intellectual labour between th surgical engineer or mechanist who invents an applies, and the surgeon who adopts mechan cal apparatus, I consider myself entitled, with out incurring any imputation of impertinen intrusion, to express my opinion as to whic form of spinal instrument best fulfils th mechanical principles demanded for the su cessful treatment of a given case.

Following the classification hitherto adopte the first instruments described are those appl cable to deformities of the pelvis; but it mu be borne in mind that this class of cases offe mechanical conditions of no slight magnitud owing to the massiveness and power of th bodily region in which such distortions a situated. I have generally found that whe pelvic deformity has arisen from old standin hip disease, or shortening of one limb, fro dislocation of the head of the femur out of the acetabular socket, and these cases are by far the most frequent, the substitution of a high boot, accompanied by the use of such an instrument as is figured at page 24, affords the best means of compensating for the discrepancy between the limbs, and of, in this way, arresting any further amount of disturbance in the relation of parts. But in those cases where the hip-joint possesses free movement, is in its normal position, and the pelvis itself the seat of distortion, then a high boot becomes exceedingly objectionable, and the instrument of American invention, figured at page 22, best fulfils the desideratum for rectification, by compelling the pelvis to accept a new and more horizontal position, from the simple reason that the leg on the uplifted side is artificially shortened by extension of the pedal base. Where the rare circumstance of rotative action between the alæ of the ilia is diagnosed, then the instrument, Fig. 4, will prevent further mischief. All the other forms of apparatus for this deformity explain themselves as given, and admit of adoption with considerable benefit.

The next variety of appliances are those for lumbar curvature, which, as has been previously explained, may occur either anteriorly, posteriorly, or laterally. For the first, which is distinguished by a deep depression of the lumbar region, with prominence of the abdominal surfaces, the best appliance is that illustrated by Fig. 13, for by its constant tendency to restore the pelvis to its correct position, through acting in correlation with the mechanical centres around which the distortion forms itself, the accomplishment of all that can be done in this difficult class of cases is secured.

For the second, which presents an enlargement of the lumbar vertebræ in a posterior direction, the best form of instrument is given in Fig. 16, as by its possession of a divided lever, the necessary pressure becomes diffused about the transverse processes of the spine, instead of producing pain on the spinous arc. Where a threat of caries or diseased action exists, this instrument is indisputably better than any other, since it fulfils the double purpose of arresting motion and of assisting the osseous consolidation of the parts.

For the third, when the spine has yielded laterally, pressure upon the apex of its arc is at once indicated as the readiest method of gradually lessening the deformity. For this purpose Fig. 10 is most suitable.

In sequence to lumbar comes dorsal curvature, which, as has already been demonstrated, rarely exists without being combined with lumbar or cervical deflection; as, however, it *is* occasionally found alone, and that both in a posterior, anterior, and lateral direction, the following forms of instrument are most applicable for these conditions.

For posterior curvature Fig. 20, by acting immediately upon the arc of curvature, whilst the lateral uprights are actively employed in extending the body, and so expanding the extremities of the curve, is the most valuable.

For anterior dorsal curvature but little can be effected, owing to the impossibility of reaching the mechanical seat of mischief, otherwise than by pressure made against the anterior surface of the thorax and abdomen. The best form of instrument is Fig. 12.

For lateral dorsal curvature, if arising from simple deformity, unassociated with destruction of osseous material, Fig. 59 best fulfils the intended object, as it acts by laterally depressing the arc of curvature, whilst the superincumbent weight of the head and shoulders is removed by the lateral crutches. When, however, destructive osseous disease has previously been established, Fig. 27 is the best form of appliance, as it perfectly and immediately removes all pressure from the diminished bony surfaces, and tends to maintain the equilibrium of the spinal column.

Next in order is cervical curvature, which, like its analogues, presents itself either in a posterior, lateral, or anterior direction. The first (posterior) is readily controlled by the use of Fig. 28, which tends to prevent the chin from approximating to the chest. The second (lateral) is best controlled by Fig. 37, which, by firmly grasping the lateral surfaces of the head, serves to secure eventual restoration of the cervix to a perpendicular line. The last (anterior) is most readily encountered by Fig. 39, which serves to keep the head from falling backwards; it is, however, right to state, that mechanical agency is of little avail in cases of pure anterior cervical curvature, as the deep depression existing between the base of the skull and the vertebræ renders any attempt at remedy by mechanical force almost abortive, for it is impossible to secure the necessary reaction, owing to the front of the neck being incapable of sustaining pressure without leading to congestion of the vessels supplying the head with blood.

In addition to the three distinctive varieties of cervical curvature just enumerated, and by far more frequently than any, there is presented a combination of the whole: thus, for example, the head is rotated—inclined laterally, and slightly thrust forward. To conquer this severe condition, either Fig. 31 or 34, are equally applicable—both having been extensively used within my own experience. The last form of spinal deformity is that which is by far the most familiarly known and frequently written upon, namely—*double lateral curvature,* the instruments and appliances for which may be described as "legion." It is, however, customary to subdivide the methods of mechanical treatment pursued, and I have followed this course in classing the instruments under four distinctive heads.

In the first (Group I.), recumbency is intended to be employed as an ameliorative agent, and as this is by far the most ancient as well as most familiar method of treatment, numerous couches have been drawn and described. The best for simple lateral curvature, arising from muscular debility, is given in Fig. 17, which assumes the form of an ordinary inclined plane, and confers upon the patient that degree of rest which her usually debilitated condition requires.

Where permanent vertebral deflection exists, and recumbency is the treatment recommended, the couch Fig. 51 offers the most useful assistance, as it combines active force for the diminution of the arcs of curvature with removal of weight from the region of the spine.

For night use, and where the curvature is consequently under active treatment during the day, no form of apparatus in which recumbency is an avowed object, fulfils its purpose better than Fig. 55, which, whilst it admits of every muscular and respiratory movement, and permits the patient to change position easily, yet maintains a never-ceasing traction upon the vertebral curves. I know of no couch which is preferable to this one.

The second division (Group II.) affects to remove weight from the spine by transferring it to the pelvis; and the appliances are intended to be used as portable apparatuses, thus enabling the patients to pursue without difficulty all their usual avocations. The simplest and best is Fig. 60, in which the object is attained without trouble or inconvenience to the person who adopts it.

The third (Group III.) contains those spinal instruments which act by lateral pressure as well as by the removal of superincumbent weight; and although a very large number are figured and described, many of which possess the most undoubted merit, I know of none, where permanent vertebral deflection exists, so well calculated to effect the intended curative object as Fig. 79. Many others possess indisputable value; yet, in the one I am now recommending, mathematical certainty is combined with anatomical requirements. If, however, the case is slight in its nature, then those appliances governed by elastic force, such as Fig. 77, are better, owing to the similitude which exists between their *modus operandi* and the retractile force of muscular tissue. Or Fig. 71 will be found of great use in such cases.

The fourth (Group IV.) and last form of appliances for double lateral curvature are those which stake their claims to merit upon gymnastic movements. Fig. 84 offers such decided advantages, as being capable of employment in the slightest or worst cases with equal propriety, that it is hardly necessary to dilate upon its excellences; it suffices to say that it has earned the approbation of all who have made trial of its efficiency.

These observations are but intended to act as a kind of finger-post towards the adoption of the better arranged forms of orthopractic instruments; it must, however, ever be a matter dependent upon the peculiar conditions of each case, as to which particular apparatus should be used. Other guidance than mine can readily be gained by those who labour under spinal deformities in the persons of their medical attendants, whose advice it is far better for them to follow than to act upon their own judgment, or rely solely on any remarks of mine, these being simply intended to assist professional men in forming their judgments, by placing before them illustrations of the most efficient varieties of spinal and other apparatuses.

CHAPTER XIV.

DEFORMITIES OF THE UPPER EXTREMITIES.

ARM, ELBOW, WRIST, AND FINGERS.

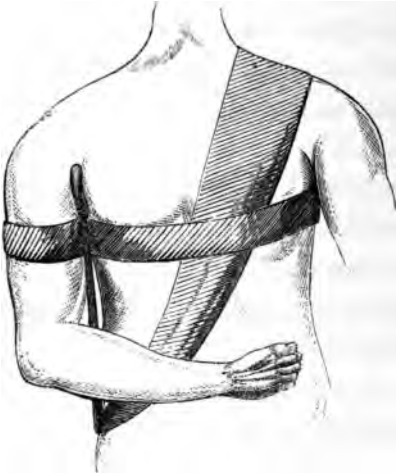
DISTORTIONS of the head and neck have hitherto been classed by the writers with those which affect the upper extremities; but as I imagine that this system of subdivision is objectionable, on the ground that deflections of the head and neck are invariably associated with those of the vertebral column, I have thought it expedient to depart from the beaten path and deal with the subject of distorted upper extremities *per se.* Although, owing to their not interfering with locomotion, these deformities are not equal in social importance, or, rather, do not attract the same attention as those of the lower extremities; they are, nevertheless, attended with considerable inconvenience to those afflicted with them, for notwithstanding the ease with which any interference with natural motion is concealed when pertaining to the articulation of the elbow or the wrist, yet as such deformities very frequently occur amongst that section of the female sex whose livelihood depends upon a free use of the hands and arms, such appliances as are calculated to restore natural mechanical function, and consequent usefulness, deserve much care and thought at the hands of surgeons as well as mechanists.

Deformities of the upper extremities are those which implicate the shoulder, the elbow, the wrist, or the fingers.

The first, namely, the shoulder-joint, is the least liable of all articulations to muscular contraction: cases, however, have occasionally arisen within my experience, in which, after a gunshot wound so severe as to necessitate amputation, the patients have been unable to extend the remaining portion of the arm (or stump, as it is generally called) in an outward and lateral direction, owing to contraction of the costal and pectoral muscles. So imperative is it, prior to the adjustment of an artificial arm, that the stump should possess free movement, that more than one apparatus has been devised for accomplishing this purpose. The best known consists of a gutta percha shield, accurately moulded to the clavicle and upper part of the scapula, and having attached a lateral lever furnished with a ratchet-joint placed in correlation with the axis of the humeral articulations, but acting, when brought into operation, in an external direction, and thus gradually extending the stump at its axillary region, a process which ultimately fits it for the reception of an artificial substitute for the arm. This appliance, though ingenious and effective, is so simple in construction that any further illustration of its form is unnecessary.

Another occasional deformity of the shoulder-joint arises from laxity of those ligaments which hold the head of the humerus to the glenoid cavity. Here dislocation of the shoulder assumes a permanent character, and thus falls within the category of distortions. The best mechanical appliance with which I am acquainted for the treatment of these cases, is that of a lever having a thick pad placed beneath the axilla for the purpose of uplifting the head of the upper arm bone. At the lower extremity of this lever a webbing-band is attached, which passes over the opposite shoulder, and thus forms a *point d'appui* for vertical resistance, and for the prevention of any displacement either of the shoulder-joint or the lever which acts against it. In addition to this oblique shoulder-band, another is fixed around the arm and across the thorax, which, acting in a lateral though horizontal direction against the thickened pad previously mentioned, assists in replacing the humerus in its proper relation with the scapula.

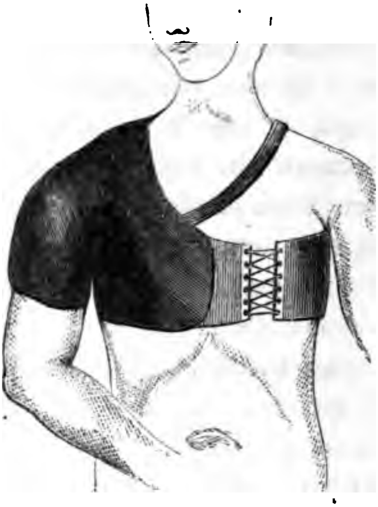
FIG. 85.



This may be considered as almost the only form of humeral dislocation which justly deserves the name of a deformity, all others being readily reduced and kept *in situ* by the ordinary Brasden bandage, which, as every surgeon well knows, consists of two padded shoulder-caps, which are buckled together behind, between the scapulæ, and thus keep the humerus from displacement until physiological ligamentous, and muscular changes have effected a maintenance of the previously displaced bone in its normal position: thus, in most instances, the future integrity of the articulation is secured.

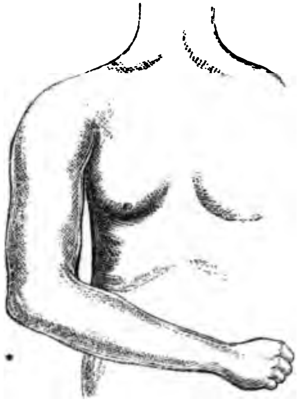
Another condition is sometimes, though rarely, met with, where from loss of power in the deltoid and spinati muscles (both *supra* and *infra*), the head of the humerus readily becomes displaced in any direction. For these cases, I have generally applied a gutta percha shield, perfectly fitted to the shoulder, and maintaining apposition between the head of the bone and the cavity on which it naturally rotates. Although this necessitates a certain loss of movement in the joint, yet it enables the arm to become useful again, a result which, during the displacement, could not otherwise be secured.

FIG. 86.



The next deformity, namely, that of the elbow, is one calculated to demand considerable ingenuity from the mechanician who has to devise appliances for its restoration, for although under ordinary circumstances the elbow-joint is supposed to have but one plane of action, yet to those conversant with mechanical anatomy it presents no less than three distinct directions of movement. It yields anteriorly from the straight position to that of ordinary flexion when the arms are folded; it rotates when the wrist is turned inwards and outwards; and is susceptible of lateral deviation under the rare condition of relaxed inter-osseous

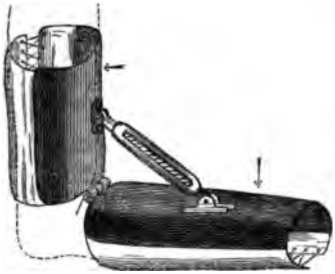
FIG. 87.



articular ligaments. All these planes of movement are occasionally involved in severe distortion of the elbow-joint, especially when the result of inflammation, rheumatism, or any other disease peculiarly affecting the joint. To commence with the ordinary form, which is that of simple flexion of a permanent character, generally due, first, to positional causes, such as constantly holding the arm in a bent position during any very long period in illness; and secondly, to the muscles having become structurally shortened or contracted. In these cases, if the muscular traction is particularly rigid, division of the tendons greatly facilitates the mechanical treatment; but under almost all ordinary conditions, the use of a well-constructed instrument will remit the arm to its natural functions without much difficulty. The selection of the best form of instrument for the accomplishment of this purpose is by no means so simple a matter as would at first appear, for with hardly an exception those who have written upon the subject recommend the adoption of a splint, furnished with an elongating screw, placed within the internal angle of the elbow-joint. It is not, however, very difficult to prove that this form of appliance is one of the most unscientific that can possibly be adopted. To guard against possible misconception of its form, an illustration of the faulty splint is appended, and I shall proceed to demonstrate its mechanical errors.

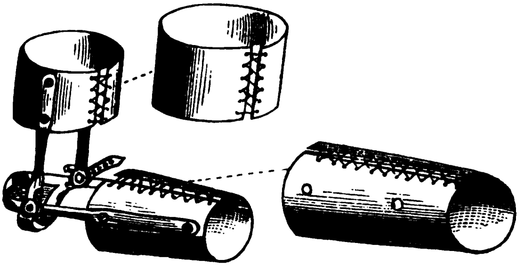
It will be perceived that the apparatus consists of a hinged splint, having an elongating screw fixed between its superior and anterior extremities; the mechanical centre of this splint, instead of coinciding with the axis of the elbow-joint as it ought to do, is placed nearly an inch above it. It therefore follows that upon extension being carried beyond a certain angle, the power of the screw becomes entirely exhausted, for never having been in mathematical agreement with the joint, its extreme extension only serves to still further disturb those mechanical conditions which are imperatively demanded while restoring the joint to a useful condition. As I have already stated, many orthopædic writers recommend this kind of appliance, forgetting, or ignoring the fact, that unless the joint of the instrument is in perfect correlation with the joint of the arm, misapplication, and consequently waste of power, must

FIG. 88.



inevitably accrue. The proper form of apparatus to be employed in such cases, consists of two lateral levers, jointed at the elbow, with a padded metal trough for the fore, and another for the upper arm. The outer joint is governed by a rack and pinion motion, which thus admits of the articulation being gently and gradually extended without pain or inconvenience to the patient. The following sketch will best explain the use of this valuable form of apparatus.*

FIG. 89.



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* At Professor Longmore's suggestion I have devised a modification of this apparatus, calculated to be of great value to army surgeons, hospital corps, &c.

Its merit consists in the upper and lower arm-troughs being arranged in "sets" of various sizes, which can be fixed or detached from the lateral levers in a few seconds. Thus the same instrument can be employed for any number of cases, by simply shifting the size of its troughs. I have also, under the same scientific advice, arranged

It must be also stated that there is a soft leathern cap which receives the elbow, and constitutes a point of counter-resistance when extension commences. The action of this instrument may be briefly described as follows: Upon extending the ratchet elbow-joint, both lateral levers move from each other in equal ratios, and as these always maintain their position along the centre of the arm, it necessarily follows that the arm itself is extended; the levers therefore represent the sides of a triangle, the base of which is furnished by a line drawn from the upper to the lower arm; thus, as the steel levers forming the sides of the angle formed at the elbow-joint, are extended, so does the base become elongated, until, upon the sides assuming the same plane, the subtending basal line becomes blended with the straight line now formed by the lines which contained the angle, and the arm is restored to a perfectly straight condition.

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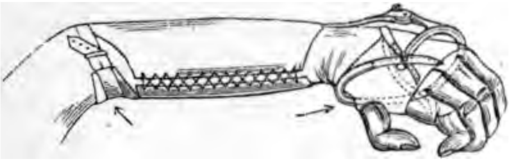
extending appliances for contracted knee on this principle, thus forming at once a good and most economical instrument.

The diagram represents this kind of arm apparatus with two of larger-sized troughs, showing the manner of their attachment to the lateral levers.

Where rotation of the elbow occurs, the apparatus, instead of being composed of two lateral levers, is furnished with only an external one, having a second ratchet centre so formed as to agree with the plane of rotation. It is, however, of extremely rare occurrence, as is also lateral inversion of the elbow. When this latter condition exists, a well padded splint, bound tightly to the arm, is the mechanical appliance adopted.

I have recently had occasion to devise a rather complicated piece of mechanism for a case where the greater portion of the radius had been surgically removed by Mr. Shillitoe, the result of which was that, although a very useful hand was secured, yet, owing to the internal metacarpal bones losing their ordinary support, falling of the hand in a lateral direction, accompanied by a shortening of the whole fore-arm, ensued. For the mechanical treatment of this distortion, two conditions are necessary: first, a restoration of the hand to its natural position; and secondly, an extension of the whole radial surface. To accomplish this is a task of no ordinary difficulty: the instrument which met the case, and that most successfully, is here figured. It is formed by a padded metal trough resting against the ulnar surface of

FIG. 90.



the arm, and taking its sole point of attachment, as far as the arm is concerned, just below the elbow. Exactly opposite the wrist, a ratchet-joint, acting in a lateral and external direction, is fixed; and in combination with this joint, a double lever is arranged, which holds the palm and back of hand between its arms. The hand is secured to these by a leather gauntlet, suspended by simple metal studs. When the ratchet is moved, two results occur: one, expansion of the radial surface of the wrist; and the other, elongation of the whole metacarpus. This instrument is given to show how important are the conditions which occasionally present themselves to the mechanician, and yet how easily they may be met by a careful study of the anatomical conditions involved.

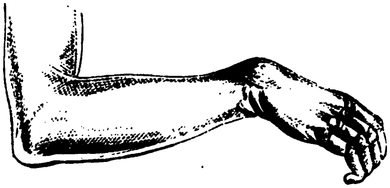
In this instance, I had the able co-operation of Mr. Shillitoe, who, by removing the diseased bone, has enabled the patient to retain a perfectly useful hand and arm, for the grasping power of the fingers remains to almost as great a degree as if no operation had been performed. It may justly be considered as one of the most marked triumphs of that greatest of modern scientific boons, Conservative Surgery.

It is well to bear in mind that, with the appliance described for contracted elbow at page 282, any degree of pure elbow distortion may with certainty be mechanically overcome, although it must also be admitted that tenotomy proves of great assistance where the muscular substances are peculiarly tense and rigid.

The next form of apparatus is that intended for deformity of the wrist joint: an articulation which also offers some obstacles to the successful reduction of the abnormal distortions to which it is liable.

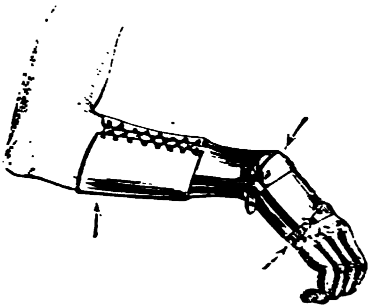
Deformities of the wrist joint are either those of simple flexion, permanent extension, transverse rotation, or lateral deviation: the whole of which conditions are also occasionally found combined.

FIG. 91.



Those distortions of the wrist which are distinguished by flexion of the joint generally, present a tense and contracted condition of the tendons which form its inferior surface; the dorsal or upper part of the joint also becoming extremely rounded and prominent. To elongate these tendons and restore the joint to its natural position, it is customary to employ, primarily, tenotomy, and then, by the use of a well-adjusted instrument, effect gradual extension of the hitherto contracted region. The appliances invented for this purpose are as follows:—Two lateral stems are affixed to a metal trough; and at the point where they coincide with the wrist-joint, a ratchet-centre is established. Resting against the palmar surface of the hand, and across the metacarpal extremities, is a softly padded plate connected with the lateral levers. When applied, the trough of the instrument receives the under surface of the fore-arm, whilst the hand-plate rests against the base of the fingers; the lateral levers being flexed by means of their ratchet-joint, so that the angle formed by the apparatus is equal to that of the contracted wrist-joint. A strong but well padded leathern band passes over the upper and prominent part of the wrist. On extending the artificial joint, resistance of the limb against the instrument occurs at the trough, the hand-plate, and the wrist-band:

FIG. 92.



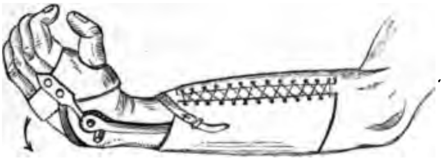
which three surfaces form the apex and base of a triangle; and as the tendinous region is involved in the base, it undergoes an elongation proportionate to the separation of the extremities of the lateral levers.

Other instruments exist for the treatment of this deformity, but they are rarely adopted; the only one, probably, in addition to those already described, that is so, being a padded splint, hinged with a ratchet-joint just above the dorsum of the wrist, upon the extension of which the anterior portion of the wrist-joint becomes uplifted, and the contracted tendons are lengthened. The objection, however, to this arrangement is, that so great an amount of pressure is engendered against the back of the wrist by reaction, that the continued employment of the mechanism becomes impossible; and an interrupted treatment rarely leads to good result.

The next form of wrist contraction is that resulting from contraction of those muscles which govern its extension. The joint is, therefore, retained in a straight and rigid position, the inconvenience of which can only be comprehended, when it is recollected how many of those natural actions which we are called upon to perform daily, demand the power of freely flexing the wrist-joint; in fact, although contraction of the extensors in such a degree as to hold the wrist in a straight position can hardly be denominated a distortion, yet it is far more inconvenient than any other form of wrist affection. The mechanical apparatus by means of which this deformity is overcome, greatly resembles that adopted for acting against contracted flexors, the only difference being, that in the latter the hand-plate passes under the palm, whilst in cases of contracted extensors the force is required to be exercised in a downward direction against the back of the hand, thus reversing the plan adopted for extending a contracted wrist-joint of ordinary appearance and character.

Another form of wrist deformity ensues when those muscles (or their tendons) which belong to the inner lateral margin, or, rather, radial region of the arm, become shortened. In this case the most valuable apparatus for overcoming the deformity, is one in which the fore-arm is received in a kind of trough, while at the centre of the wrist, and on its upper or superior surface, a ratchet centre is placed, corresponding as far as possible with the axis naturally formed by the bones of the wrist (metacarpus) in their displaced condition. The hand itself is also enveloped by a padded plate surrounding both its palmar and dorsal surfaces, and connected with the centre ratchet just mentioned. On bringing this instrument into operation, extension of the inner margin of the wrist becomes engendered, which is the object entertained in adopting it.

FIG. 93.

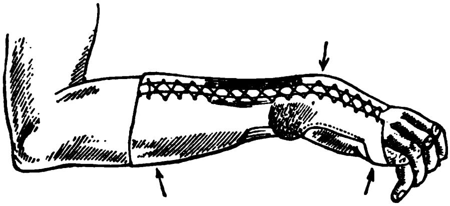


Rotation of the wrist upon its own axis, although a rare form of distortion, sometimes exists; to remedy this, the same instrument as that just described is employed, with this difference, that the ratchet motion occurs in a plane transverse to that of the dorsal surface of the hand, and thus gradually rotates and replaces the hitherto disturbed osseous structure.

Another condition of deformity, constantly met with in the wrist articulation, is that resulting from paralysis of those muscles whose duty it is to extend the hand. This distortion is therefore characterized by inability to upraise the hand, which consequently droops and is utterly useless to its owner. The mechanical treatment indicated by this condition is, the discovery of some means by which the equilibrium which should naturally exist between the extensors and flexors of the wrist-joint may be artificially restored. To effect this, I have generally employed the force of vulcanized elastic cords, which by simulating the retractile energy of muscular substance fulfils better than anything else the required functions. The form presented by an instrument constructed on this principle is here given, and its value may be at once understood when it is stated that, by its use, a patient can be made to use his pen or pencil, knife and fork, or any other domestic implement.

Sometimes a helical wire spring is adopted instead of the vulcanized cord, but whatever the mechanical agent employed, only one feature presents itself, which is the necessity for antagonizing those tendons that are already contracted, and supplying the paralyzed muscles with artificial power.

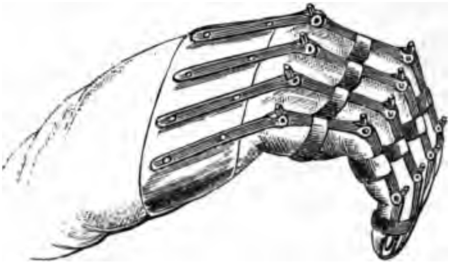
FIG. 94.



The next variety of deformity to which the upper extremities are subject is contraction of the fingers, which although apparently trivial, if the form and extent of the distortion be alone remembered, is nevertheless more inconvenient to the patient than, probably, any other articular distortion. For the prehensile power exercised by the human hand to be perfect, it is requisite that there should be free play in those joints which enter into the movements of the fingers. Simple as are the acts of tying a neckerchief, or picking a pin from the floor, when the fingers are in their natural state of freedom, how clumsily are such offices performed when an accident or other causes have interfered with the normal integrity of any of their many joints. The remarkable structure of the human hand has been splendidly set forth in Sir Charles Bell's elaborate and noble "Bridgewater Treatise," and probably no better subject could ever have been selected for displaying the wonderful works of the Creator than this part of man's body. When therefore we bear in mind that the whole practica value of the hand, as a prehensile implement depends upon the true and perfect manner in which the fingers perform their functions, too much praise cannot easily be awarded to any form of mechanical appliance which will with certainty restore extension and usefulness to any of its contracted components. The fingers may either be contracted singly or in the entire series, and as the latter evil renders the hand completely useless, I will proceed to detail the kind of instrument which I recently arranged for a patient of Mr. Fergusson's, all of whose fingers had contracted through the effects of a sword wound in the palm of the hand.

The gentleman whose case I am about to quote was an officer in the Indian service, and received his wound from a tulwar during the Sikh campaign, when, owing to the heat of the climate, considerable sloughing and consequent destruction of integumentary tissue took place. On the wound becoming cicatrized, it was found impossible, in consequence of the contraction established by inflammatory action in the palmar flexors, to open the fingers even sufficiently wide to admit the handle of a sword. On coming to England, this officer placed himself under Mr. Fergusson's care, at whose wish and suggestion the following instrument was adjusted.

FIG. 95.



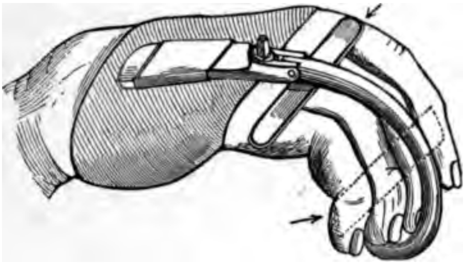
It will be seen that a padded plate rests upon the upper surface of the fore-arm, to which are attached five levers, four of which correspond with the direction and form of the fingers, and one with the thumb. Corresponding exactly with each articulation is a ratchet-joint capable of being moved by a key, and the fingers are bound to these levers by a piece of narrow black ribbon. On moving either of the artificial articulations, a corresponding extension of the joint of the finger over which it is placed results. It will therefore be perceived that no less than fourteen distinct axes of extension are required in treating the thumb and fingers.

In the case to which this instrument was applied, a very useful hand was obtained: its owner was enabled to hold his sword and perform almost any act dependent upon the free use of the fingers.

Another very valuable invention for contraction of the fingers is formed as follows:—

A padded leathern pad surrounds the wrist, to the upper surface of which a socket is attached; in this socket a curved lever, having two horizontal bars, is fixed. One of these bars passes under the palmar surface of the first joint of the fingers, the other passes over the dorsal surface of the third joint of the fingers. A small ratchet centre also exists in the curved lever, which, upon being moved gently, extends the whole of the fingers, by pressing upon them at the back while uplifting from beneath their extremities. This appliance is calculated to overcome the most severe case of finger deformity.

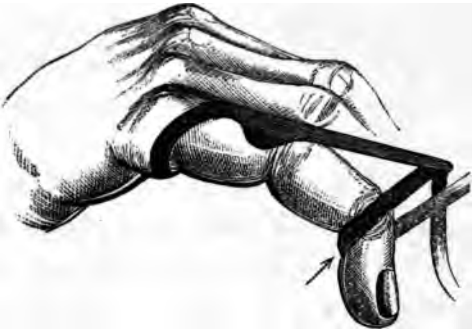
FIG. 96.



When the forefinger is contracted, as most frequently occurs, a little plate placed at the back of the hand, and furnished with a lever acting similarly with those arranged in the more complicated apparatus, soon restores the part to its natural form. In fact, in the whole range of orthopædic science, the treatment of contracted fingers becomes the most certain and simple.

Occasionally amongst young ladies who play the piano, the little finger becomes contracted, but to so slight an extent, as not to preclude the striking of a musical octave, or occasion any great inconvenience; yet, as the fact of possessing a contracted finger is naturally thought a blemish, its mechanical treatment becomes demanded. To effect this, I have invented a very simple arrangement, viz.—a small spring so curved that it folds round the base of the finger, and presents a lever passing along the under surface of the contracted joint. By binding this with a piece of ribbon, extension of the finger is secured without even for an instant arresting the power of playing the piano. It is a very pretty piece of mechanism,

FIG. 97.



and greatly tends to strengthen the striking power of the little finger, which, as all musicians know, is a matter of great moment when difficult concerted pieces are to be performed.

The fingers may, however, assume a contracted form in consequence of paralysis of the extensor muscles. When this occurs, a gutta-percha trough neatly moulded to the part, and calculated to keep the finger in an extended position, is all that is necessary for restoring it to perfect form, and also assisting the retraction of over-elongated muscular substance.

These appliances complete the list of those usually employed in deformities of the fingers or wrist, and also bring me to the end of my entire subject, as they complete a series of descriptions and illustrations of the various orthopractic mechanisms which skill and experience place at the disposal of every surgeon.

In concluding a task begun simply with a view of compiling and classifying such pieces of mechanism as had hitherto been found valu-

mencing these pages was merely that of affording to the professional world that assistance, which can alone be given by a concise and clearly arranged explanation of the salient points presented by such mechanical appliances as have during late years been invented and perfected for the scientific treatment of deformities. In all those instruments which are cited and recommended, great care has been taken, not only to render them perfect as works of ingenuity and art, but also to demonstrate that a new science well worthy of the attention of all well-governed, refined, and rightly educated minds, has been established by the labour taken to raise to the standard of a liberal profession the invention, construction, and arrangement of orthopractic mechanism.

To pursue its objects perfectly demands a combined knowledge of mechanics, mathematics, anatomy, physiology, and surgery, for unless the mechanist has studied these, all the directions and suggestions of the surgeon who seeks mechanical assistance in the treatment of his cases must be utterly unintelligible, and would be about as much appreciated by his

able in the ameliorative or curative treatment of deformities of the whole body, I cannot be unaware of the numerous deficiencies which have been entailed by the hasty manner in which my undertaking has been accomplished. Written for the most part by night, during those few moments which were obtainable after a long day's active employment, there will probably be found a want of comprehensiveness in the details as set forth. Since, however, no work has ever yet been solely devoted to a consideration of orthopractic mechanism, I feel assured that the indulgence of my readers may not only be asked for, but eventually gained. The scope of the work has been of so practical a character as almost entirely to preclude (except in rare instances, where theoretical knowledge alone rendered the descriptions of instruments intelligible) any speculation as to the influence exercised, by successful restoration of deformed parts to their pristine condition, on the minds of those who had hitherto been harrowed by the supposition that no permanent mechanical relief could ever be looked for.

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auditor as the lectures of a Dindorf or Gaisford if addressed to the unclassical beldames of Billingsgate Market.

In conclusion, I have honestly and earnestly tried to advance my profession to its true position, well knowing that it has not hitherto been considered as ranking higher than a mere handicraft, yet feeling deeply convinced that its proper fulfilment could alone be secured by long experience, careful study, and a just appreciation of its intellectual requirements. Surgery itself has but emerged from empiricism within the last hundred years, and it is quite possible that a future generation will find in the device and adaptation of mechanism to the treatment of deformities and diseases, an occupation worthy of minds of the highest order of thought, and practical energy. At present the subject has been but lightly touched upon, but sufficient interest is undoubtedly awakened to render its further pursuit as probable as it is unquestionably desirable.

I cannot end this volume without frankly admitting the deep sense of obligation I feel myself under to those surgeons, who by entrusting

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Also, by the same Author,

ON ARTIFICIAL LIMBS,
THEIR
CONSTRUCTION AND APPLICATION.

From Her Majesty the Queen.

"BUCKINGHAM PALACE, *September* 5, 1855.

"SIR,—I have the honour to acknowledge the receipt of your Letter of the 3rd inst., accompanying your work upon Artificial Limbs, which I have laid before the Queen, and which Her Majesty has been graciously pleased to accept.

"I am, Sir, your obedient, humble servant,
"To Mr. Bigg. C. B. PHIPPS."

"The author has done well to publish his experience at the present time. He teaches the scientific principles upon which the different parts should be manufactured, so that, in the hands of a competent mechanician, the artificial limb may not only prove pleasing to the eye, but useful to the wearer. Some excellent remarks occur upon the form of stump best suited to the adaptation of artificial means."—*Lancet.*

"The surgeon who desires to procure an artificial limb for a patient may consult Mr. Bigg's pamphlet with advantage."—*Medical Times.*

"Our surprise is that a work of this kind, explaining the various forms of mechanism employed as substitutes for lost limbs, and the principles of their application, has not long ago been offered to the profession. Every medical man must have felt at some time or other the necessity of possessing such information as this book conveys."—*Medical Circular.*

"The author has bestowed very great pains on the work, and from the numerous diagrams has made the mechanical contrivances very clear: every artificial extremity appears to be admirable in theory and ingenious in practice."—*Dublin Medical Press.*

"A book of this kind, at such a moment, cannot fail to be considered a public benefaction; and to refer to it such persons as need its aid is a public duty."—*Art Journal.*

"In Mr. Bigg's inventions the action of the living limb is closely followed, and its loss as nearly supplied by mechanical apparatus as the closest study of the subject could enable the intelligent mechanician to effect. Our best and confident recommendation of this admirable little work will be most forcibly expressed, perhaps, by our saying that Mr. Bigg has not overstated his pretensions."—*Era.*

"The little book is very clearly written, and cannot but be highly acceptable to all who may have been deprived of their limbs; and they will be surprised to find how greatly science and mechanism can relieve their misfortunes."—*Weekly Times.*

"The writing is clear and forcible; and the facts revealed will astonish and please those who may have been so unfortunate as to have lost a limb."—*London Evening News.*

And, by the same Author,

DEFORMITIES,

AND THE MECHANISM REQUIRED FOR THEIR TREATMENT.

From His Royal Highness the Prince Consort.

"COLONEL PHIPPS has received the Prince Consort's commands to thank Mr. Bigg for sending his book, which has been accepted by his Royal Highness.

"This answer would have been sent to Mr. Bigg sooner, but for the pressure of business.

"BUCKINGHAM PALACE, 22nd February, 1858."

"There is no other book in the range of our medical literature which conveys so much practical information as to the mechanical appliances necessary in the treatment of the deformities of the lower limbs. And we would commend this little work to the attention of all surgeons, both for the fulness, the accuracy, and the intelligence by which it is characterized."—*Lancet.*

"Mr. Bigg himself appears to be well acquainted with the anatomy of the bones and muscles connected with the deformities he describes; and his descriptions, therefore, of the construction and uses of the various apparatus employed deserve and will command attention. His book must prove of very great value to those practitioners who wish to treat cases of deformity brought under their care without consulting any of the gentlemen who have devoted special attention to orthopædic surgery." —*Medical Times.*

"We consider this work indispensable to every practical surgeon."—*Medical Circular.*

"The importance of this department of applied surgery it is impossible to overrate; for the highest operative skill would, in many instances, be exercised in vain, unless the orthopædic appliances were properly adjusted to the exigencies of each particular case."—*London Medical Review.*

"Although the treatise is eminently practical, the author has not dealt with his subject as a mere matter of manipulative skill, but he has shown an enlarged acquaintance with the science of orthopædy, which has made such rapid strides within the last few years, and to the progress of which so many of suffering humanity have had great reason to be thankful. The book is written in a clear and simple style, and the diagrams and illustrations are very numerous. The ingenious and skilful author has good reason to hope that his treatise will find favour with the whole body of the medical profession."—*Morning Post.*

"A treatise of real importance to the medical profession."—*Leader.*

"The work of Mr. Heather Bigg has been written with the view of placing a detailed description of such apparatus as are peculiarly well calculated to effect the mechanical cure of the more ordinary forms of malformity at the disposal of the medical profession. Many of them are capable of being used in cases where tenotomy is unnecessary or undesirable; others are especially constructed for the purpose of elongating contracted muscles, after their tendons have been divided; almost all will be found valuable and necessary adjuncts to the treatment of some one or another of the multitudinous distortions which pass beneath the eye of most surgeons."—*Morning Chronicle.*

"Mr. Bigg is already widely and favourably known, both to the medical profession and the general public, for his talent and experience as a constructor of scientific anatomical appliances, but the work before us proves clearly that he is possessed of scientific attainments of no common order. We are pleased with the terseness and fluency of his writings, and the modest and gentlemanly manner in which his opinions are advanced. He has successfully shown that he is worthy of occupying a high social and scientific rank; for in describing the necessary qualifications for becoming a good mechanist, he raises the educational standard of that profession."—*Illustrated Inventor.*

"Nous venons de lire avec le plus grand intérêt un des plus habiles livres du jour; il est intitulé *Bigg sur les Difformités;* c'est surtout dans la guérison des recourbures de l'épine dorsale et du pied-bot que Mr. Bigg a montré un talent à la fois original et savant."—*La Presse.*

"We cannot sufficiently express our approbation of the manner in which Mr. Bigg has executed his task, our admiration being almost equally divided between the letter-press in which each instrument is truly yet clearly described, and the plates which beautifully illustrate his explanation, and in the number of which he is lavish. In his works Mr. Bigg has clearly established that he is a *mechanician,* not merely a *mechanic,*—a distinction for which we are indebted to himself; and that he is an enthusiast in his art, may be inferred from the unction with which he dwells on some of his substitutes for nature's own work."—*Dub. Quar.*

Also, by the same Author,

GYMNASTICS.

APPLIED TO THE TREATMENT OF DEFORMITIES.

"In the present state of public knowledge and opinion it seems to us that more useful is the man who opens a gymnasium than he who endows a college; more valuable he who lays out a playground than he who builds a school."—*Times.*

"Muscular exercise has always been held in theory to be an important auxiliary to the mechanical treatment of the deformities of the body. To carry so important a rule into practice, Mr. Heather Bigg, the anatomical mechanician to the Queen, has visited the orthopædic institutions of Vienna, Berlin, &c., and is implicitly following out the valuable information gained by his tour of inspection."—*Morning Post.*

"The title of this work fully explains the very important nature of its contents, Mr. Bigg having visited Vienna, Berlin, Stuttgard, Dresden, &c., to make himself the more conversant with the rational treatment now pursued in those cities by the most eminent men for all cases of deformity. Mr. Bigg does not hesitate to acknowledge the sources of his present inspirations, and like all men placed by sheer intellectual ability in the first ranks of their profession, he frankly avows that, in adopting a gymnasium at his professional residence in Leicester-square, he does so to permit of medical men fully testing a practice at home, which has been so eminently beneficial abroad."—*Observer.*

"So strongly, indeed, has Mr. Bigg become convinced that strength of sinew and stamina of muscle can only be obtained in conjunction with mechanical treatment, but by bodily exercise, that he has fitted up the whole requisite appliances upon the best foreign models, to which he has given a general invitation to the medical profession."—*Globe.*

"MUSCULAR EXERCISE IN MECHANICAL TREATMENT.—A very important theory with reference to bodily deformities has recently been carried into practice by Mr. H. H. Bigg, the successful anatomical mechanician to Her Majesty, which consists in strengthening by muscular exercise that which is gained during the progress of mechanical treatment. With this object Mr. Bigg has visited the orthopædic institutions of Vienna, Berlin, &c., and is implicitly following out the valuable information gained by this tour of inspection, the facts of which he likewise gives to the profession, in a brochure just published by Churchill, of New Burlington-street."—*Sun.*

"Among useful pamphlets we may draw attention to a clever little work on 'Localized Movements; or Muscular Exercises, combined with Mechanical Appliances, for the Treatment of Spinal Curvature and other Deformities.'"—*Leader.*